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Vol. XIV, No. 11

SEPTEMBER, 1955

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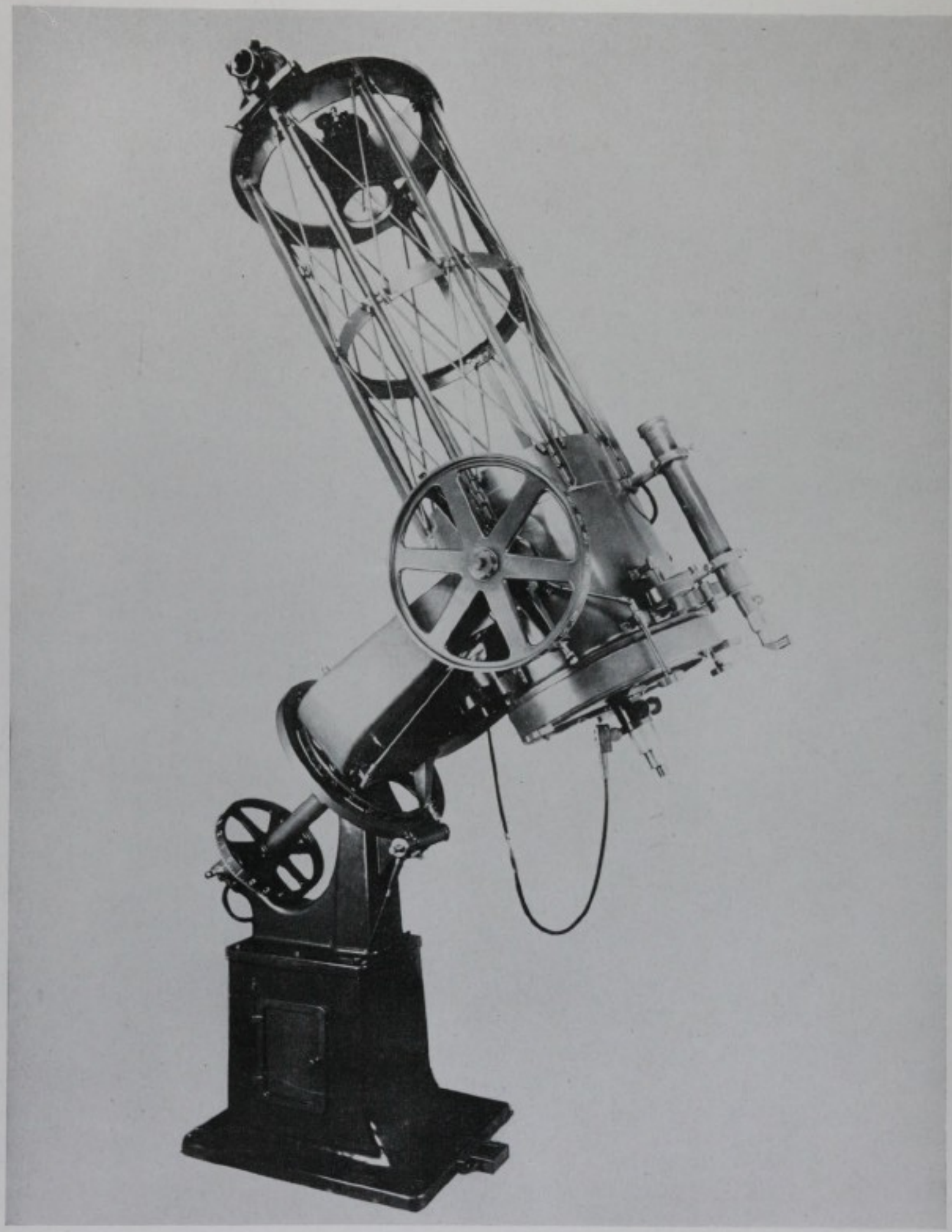
Eclipse in Ceylon

Stars for September

Amateurs Convene at Seattle

Some Unusual Short-period Variables



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Sky and TELESCOPE

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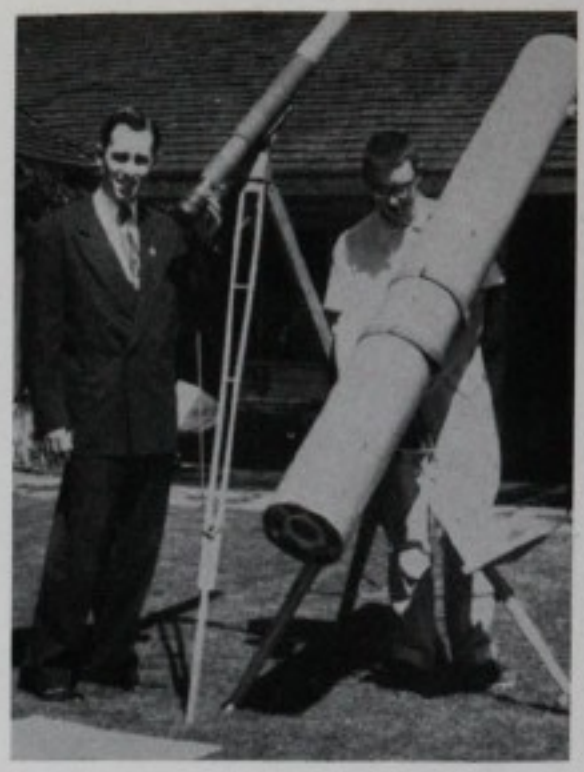


Two discoverers of Comet 1955f were (left) Karl Krienke, seen here with his 3½-inch refractor, and Lewis Macfarlane, who used the 8-inch reflector shown here and on the front cover. Photograph by Guy R. Blackie.

Comet 1955f

ONLY A MONTH after discovery of the naked-eye Comet Mrkos, observers on opposite sides of the world picked up another somewhat fainter comet, independently and nearly simultaneously.

The first discovery of Comet 1955f was by A. Bakharev, a meteor specialist at the Stalinabad Observatory in Russian Central Asia. On July 13, 1955, at 19:20 UT, he found a diffuse 8th-magnitude object in the constellation Pegasus, at right ascension $22^h\ 50^m.7$, declination $+20°\ 25'$, moving northwest among the stars at a rate of nearly two degrees per day.

This news was transmitted to Moscow, and from there to the astronomical information center at the Copenhagen Observatory, reaching Harvard Observatory on the morning of July 15th. Other information about Bakharev's discovery is lacking, but there are full details about the independent detection of the comet 12 hours later by two amateurs in Seattle, Wash.

Lewis Macfarlane and Karl Krienke, together with the latter's father, had been looking at various celestial objects with a 3½-inch refractor and the 8-inch reflector that is shown on the front cover, on the evening of July 13th. The younger Krienke is an instructor in mathematics and physics at Seattle Pacific College, and Mr. Macfarlane is a senior at Roosevelt High School.

At 11:00 p.m. PST, they accidentally found a dim patch of light, in the approximate position $22^h\ 55^m$, $+21°$. In-

(Continued on page 451)

Eclipse in the Philippines

At Hans Arber's observatory in Pasay, a group of his neighbors observe the eclipse of a sun that is very high in the sky. The observatory roof is only partly open.

AS VETERAN eclipse observers know, there is often little relation between the weather at the moment of totality and the average or expected weather for the place of observation. This proved the case at Manila and other favored observing points in the Philippine Islands at midday on June 20th.

Reference to the Philippine weather statistics on pages 142 and 143 of *Sky and Telescope* for February will show, however, that the clear eclipse sky for Manila was not unusual, for the chances of successful ground observations there had been set at between 30 and 40 per cent by the Philippine Weather Bureau. The sun was clearly visible at noon on more than half of the days in June the year preceding the eclipse.

The Philippine eclipse story is summarized by the following reports:

FACING PICTURE: Taken from Quezon City, about 10 miles from downtown Manila, with the 6-inch f/16.4 refractor at the Philippine Weather Bureau Astronomical Observatory, this is a one-second exposure of the corona made at mid-totality on June 20, 1955, on Kodak Tri-X film. North is at the left. The photograph was forwarded by Dr. C. del Rosario, director of the Philippine Weather Bureau.

Three Americans who flew to the Philippines and observed the eclipse from the Manila Hotel are seen here at the Seattle convention of the Astronomical League. They are Robert H. McDowell, Portland, Ore., Mr. and Mrs. George A. Kovaka, Pacific, Mo. The sun emerged from clouds half a minute before the beginning of totality, which they saw perfectly.

Eclipse Drawings

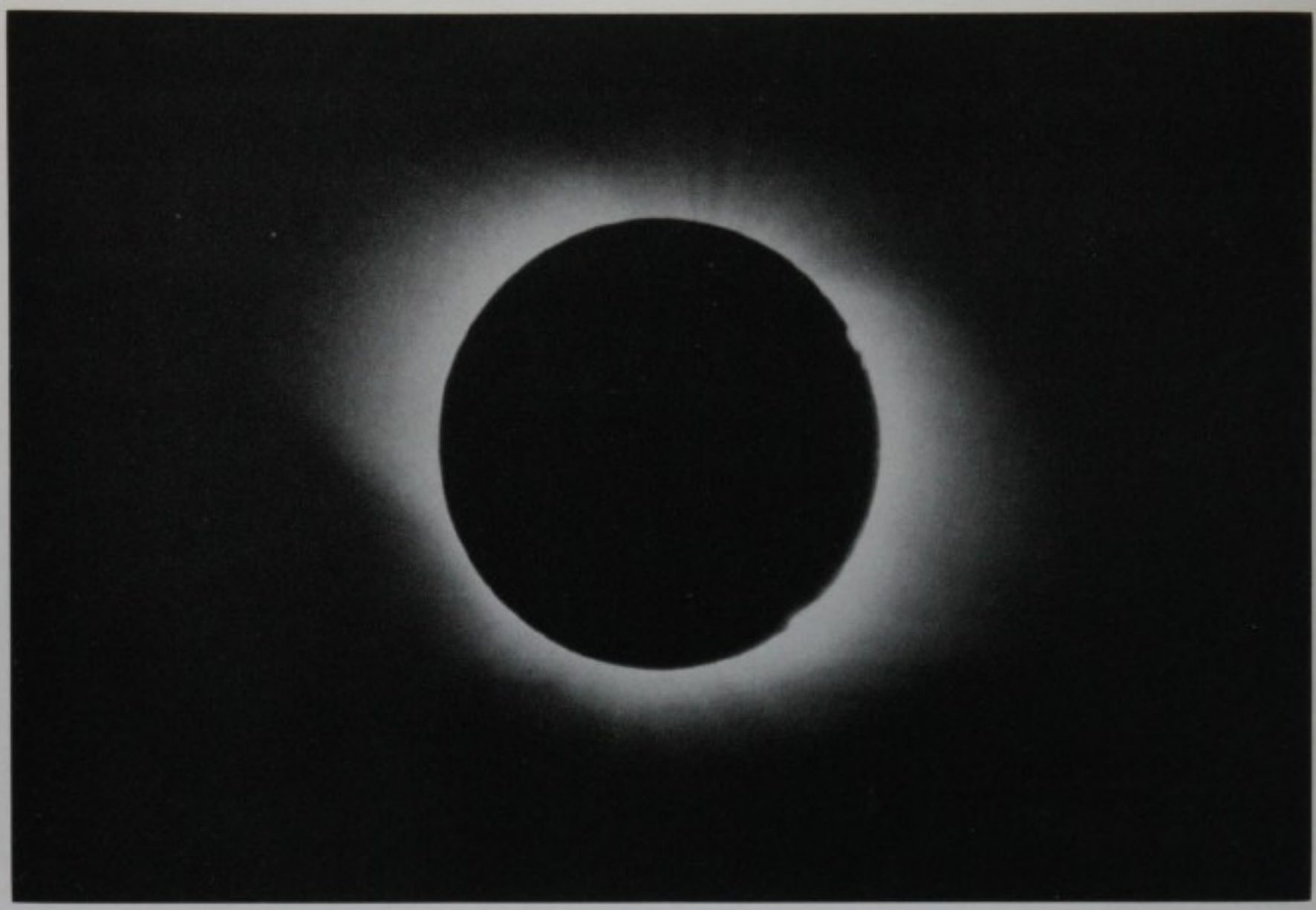
As it was the rainy season here, we had only a slim chance to see the eclipse. I am an amateur astronomer 17 years old living more than 300 miles north of the path of totality, and decided to travel by bus to Manila. I observed from a friend's lawn in San Francisco Del Monte, Quezon City, just northeast of Manila, where the duration of totality was only a few seconds short of six minutes.

On the morning of the 20th, while the sun rose unclouded, I set up my 3-inch refractor. I took weather observations until the eclipse ended and, as I had no suitable photographic equipment, made drawings of the eclipse. Using a power of 31, I began at 10:26 a.m. with a picture of the sun, on which there were very few spots, only about three good-sized ones.

At first contact the sun was covered by a cloud, but my drawing at 10:48 shows a tiny bit of sun cut out by the moon. Drawings were made at intervals thereafter, as the series on page 450 shows.

Then at 12:18:30 the moment came. The diamond ring began to show, with the area of the diamond extending about 10 minutes of arc along the east limb and quite bright. At this same time I noticed the shadow bands, about two inches wide and six inches apart, racing from east-northeast to west-southwest. Then full totality came.

This was the most beautiful celestial phenomenon I have ever seen. I saw two prominences, one on the northern and one on the eastern limb; they both were about 1½ minutes of arc high. The corona with its equatorial streamers measured a little more than three sun



In this one-second exposure, made by Hans Arber at his Pasay Observatory, the inner corona in the polar regions of the sun has a pronounced spikelike appearance. Mr. Arber used a 4-inch refractor, and Royal Pan sheet film. North is at the top. Two bright prominences, through overexposure, appear to encroach upon the moon's disk.

diameters from east to west. It was somewhat yellowish near the sun, turning whiter farther out. There were many distinctive coronal spikes, especially noticeable on the north and south limbs.

During totality, as it was partly cloudy, I saw only Venus to the west of the sun, and Sirius to the southeast. The sky overhead appeared about as it does on a night when the full moon is about one hour up. The horizon was considerably brighter, with clouds at a good distance reflecting some light into the area.

After about three minutes of totality, a cloud passed over, obscuring the rest of totality and the third contact. A few minutes later it cleared up again, and I recorded partial phases at intervals from 12:34 until 1:20, when it clouded permanently, obscuring last contact at 1:52.

During the eclipse, there was an air temperature drop of 10 degrees Fahrenheit.

After the eclipse, I redrew all my pictures in color.

JAMES E. CAMPBELL
Box 49, Aparri, Cagayan
Philippines

Successful Photography

Observing in Manila, I was able to make a successful series of eight pictures of the corona. My instrument is a 4-inch f/15 refractor with an H & W synchronous motor drive.

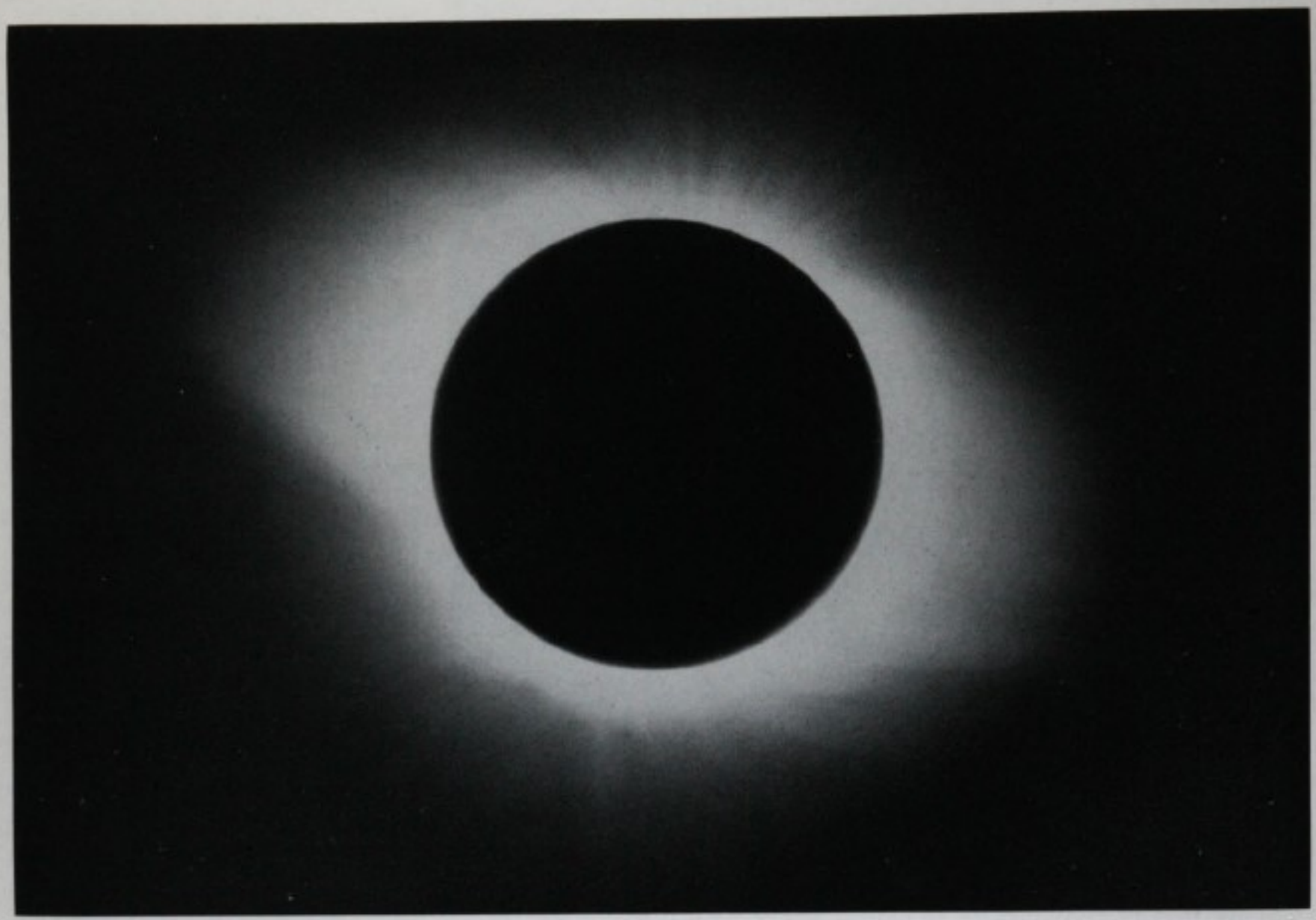
We were very fortunate to have a perfect clear sky during totality. Although clouds covered the sun at first contact, half an hour before totality the sky near the sun was absolutely clear and allowed a fine view. Almost two minutes before total eclipse Venus was clearly visible, and shortly thereafter Jupiter could be seen. I did not find time to look for constellations, since I was completely absorbed in my photographic program.

About a minute before totality I began working in the observatory, with only one boy scout as my assistant. I am astronomy merit-badge counselor for boy scouts in the Philippines.

I failed to get a good picture of the diamond ring and of Baily's beads. In spite of careful preparations and many test exposures, during totality I had difficulties operating my camera; the roof of my telescope shack was only partly open, so that I had to grope in the dark for a flashlight, and only then did I manage to start taking shots.

I also had an 8-mm. movie camera in operation, and another camera was set up pointed to a white sheet to record

James E. Campbell's series of ink drawings, made in Quezon City, record the progress of the eclipse from soon after first contact until half an hour before last contact. Clouds obscured each contact but second, and blotted out about half of the six-minute totality. The drawings were made, from left to right, at 10:48 a.m. Manila zone time; 10:56; 11:14; 11:36; 11:46; 11:56; 12:04 p.m.; 12:18:30 (second contact); 12:19:30 (during totality); 12:34; 12:46; 1:00; 1:10; 1:20. North is at the bottom.



As in June, 1954, the sun's corona was still strongly of the type corresponding to minimum solar activity. Compare this three-second exposure by Hans Arber with that by Roland Rustad, Jr., on the cover of the September, 1954, issue.

the shadow bands in the fleeting seconds before and after totality.

The temperature drop during the entire eclipse was from 93 to 84 degrees Fahrenheit, much less than had been anticipated. A visitor at my observatory to photograph and view the eclipse was W. T. Edwards, of London, a member of the Royal Astronomical Society.

HANS ARBER
P. O. Box 125
Manila, Philippines

Partial Eclipse Rained Out

In the Iloilo district, south of the path of totality, up to the beginning of the eclipse there had been a perfect day. Then, after about 40 per cent of the sun was covered, about 12:20 p.m. local time, I had never seen such a cloudy sky—winds and rain becoming almost a little "baguio" storm. Thereafter we did not see the sun, except for occasional glimpses, until noon the next day.

Here in my mission of Tubungan there was a hush over the place during the event, and hardly anybody was walking about. They all stayed indoors, and not only to gain shelter from the rain, for the Filipinos are superstitious about an eclipse as they are about many natural phenomena.

We could not gauge the maximum darkness on account of the clouds, but it was something like 6 p.m., shortly before sunset. I noticed nothing unusual about my animals, pigs, chickens, cats and dogs, during the event.

REV. JOSEPH P. BRERETON, MHM
Convento Tubungan
Iloilo, Philippines

COMET 1955f

(Continued from page 447)

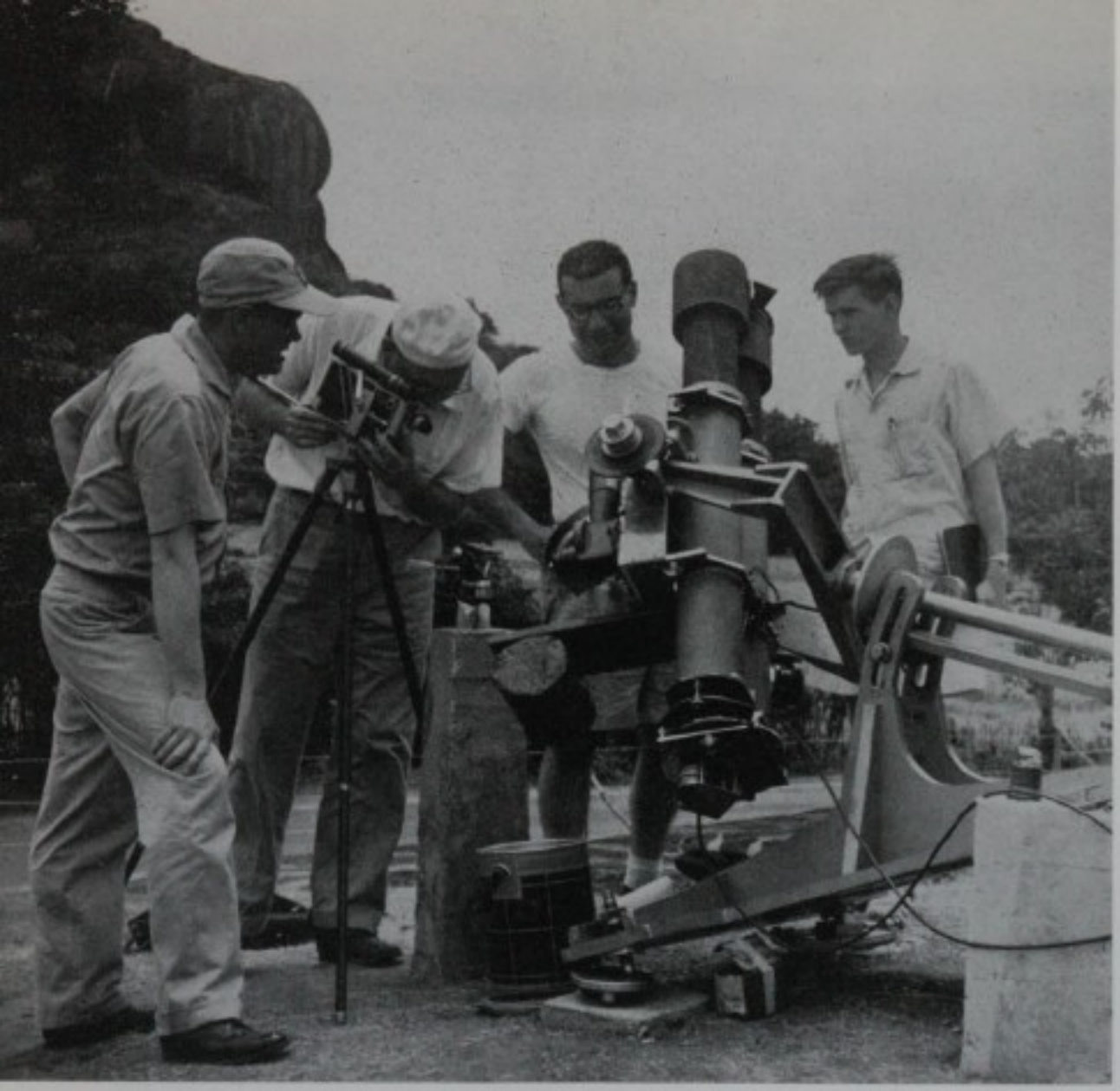
spection of the Skalnate Pleso atlas and other reference works showed no known nebula or cluster in the vicinity. The 8th-magnitude object appeared diffuse and fairly extensive, with a central condensation, and it was noted as fainter than the Dumbbell nebula, M27. Krienke followed the suspected comet with the 3½-inch, and Macfarlane plotted observations made with his 8-inch at 30-minute intervals until 1:05 a.m. They found it was moving northwest.

The following evening both observers picked up the object two degrees from its position on July 13th. There could now be no doubt that it was a comet, and a telegram was sent to Harvard Observatory reporting the right ascension and declination of the comet on each date, together with its description and other details. This wire reached Harvard about an hour before the one transmitting the Russian discovery.

Within a week of the discovery of Comet 1955f, the first calculation of its orbit was made by Dr. L. E. Cunningham, of the Leuschner Observatory. He made the assumption that the path of the comet with respect to the sun was a parabola. The comet had passed through perihelion (nearest to the sun) on July 11th, a few days before its discovery, when it was slightly inside the orbit of Mars.

The plane of the comet's orbit is tilted 50 degrees to that of the earth's orbit. Since the comet passed through its ascending node just before discovery, it will remain in the northern sky. However, its distance from the sun and from the earth are both increasing, so the comet will become steadily fainter.

Among the first amateurs in America who observed the new comet was Robert Burnham, Jr., of Prescott, Ariz., who picked it up on the morning of July 20th. He reported it as a 7th-magnitude object about a quarter of a degree west of Eta Pegasi. The comet had a bright center, but no tail was visible to Mr. Burnham in his 6-inch reflector. Its northerly motion was evident during his two-hour watch.



At the Harvard expedition site in Ceylon, Sigiriya Rock is seen in the left background. Left to right are J. M. Chamberlain and Lee Boltin, Hayden Planetarium; Dr. Harold Zirin and Owen Gingerich, Harvard. The twin telescopes on the fork mounting, each with a telephoto lens of 36-inch focus, were for measuring the color of the corona. At the bottom of each tube are phototransistor detectors which receive light through filters mounted on a motor-driven wheel. The mounting for the infrared spectrum camera may be seen on the pier to the left of center; Dr. Zirin is looking at the disk of the reflection grating that fed this camera; the grating is mounted near an elbow finder telescope. The principal mounting, lower right, had to be tilted noticeably because of the low latitude of Ceylon. American Museum-Hayden Planetarium photograph.

Eclipse in Ceylon

J. M. Chamberlain
American Museum-Hayden Planetarium

and

Owen Gingerich
Harvard Observatory Eclipse Expedition

FOR MANY YEARS astronomers had been eagerly anticipating the eclipse of June 20, 1955. The duration of totality was to reach a maximum of seven minutes 7.8 seconds (in the China Sea), a record not exceeded since the mid-Pacific eclipse of June 13, 717, and not to be broken again until June 25, 2150. Perversely, on June 20th the path extended almost exclusively over water, crossing only a few land areas, chiefly Ceylon, Thailand, Indo-China, and the Philippine Islands.

Encouraged by the exceptional duration of totality, expedition organizers sought a location where meteorological conditions would be favorable to observations of many kinds. In June, however, the southwest monsoon prevails over Ceylon and Indo-China, and there is considerable cloudiness over the Philippines. In Ceylon, the most dependable buffer against these conditions appeared to be Pidurutalagala, the 8,300-foot mountain east of Colombo, and the range of lesser peaks that attend it; thus the plains on the eastern coast of the island appeared to offer the most favorable weather opportunity.

In 1954, the Ceylon department of meteorology had placed four sunshine recorders in the eastern plains during the period May 20-July 20; these records indicated an 80-per-cent chance of clear skies on eclipse day. Trans World Airlines, on the basis of four-year records from several stations, suggested that even better chances were to be expected on the east coast itself, where the greatest duration of totality on the island, four minutes 47 seconds, would occur just a few miles north of Kalkudah.

Hingurakgoda. This region, about 10 miles north of the central line on the eastern plain, seemed the best compromise between duration of totality and favorable weather; it was in this vicinity that the greatest number of expeditions concentrated.

The most elaborate single observation planned was to remeasure the bending of starlight around the sun, as predicted by relativity theory. Fifteen tons of equipment from the Potsdam Observatory were set up at the Hingurakgoda airport. The East German astronomers worked in co-operation with Prof. H. von Klueber, Cambridge, England, who had used the same Zeiss equipment in 1926 and 1929, and who was group leader. Assisting were Dr. A. H. Jarrett, St. Andrews, Scotland, and Prof. A. W. Mailvaganam and his students from the University of Ceylon.

The double-camera arrangement, shown in the photograph, permits simultaneous

recording of the eclipse star field and another nearby star field. Since a single large flat mirror reflects the light into both cameras, it is possible to determine any distortion of the eclipse field introduced by the flat, by measuring star positions in the comparison field. Prof. von Klueber termed the star field surrounding the sun on June 20th "only moderately good," but he hoped that the darkness during a relatively long eclipse would work in his favor.

In the airport building, the English astronomers had set up an interferometer to determine the coronal temperature using the green coronal line at 5303 angstroms.

From Meudon Observatory in France, Dr. A. Dollfus also used the airstrip as an observing site. His equipment included a Lyot interference filter for the hydrogen-alpha line, and he planned to separate photographically the Fraunhofer or F-corona and the continuous or K-corona. The latter is a very hot extension of the sun's atmosphere, and its spectrum shows emission lines. The F-corona, on the other hand, is related to the zodiacal light, and is produced by the scattering of sunlight from particles in interplanetary space. Thus, the hydrogen-alpha line appears in absorption in the F-corona just as in ordinary sunlight, but it is invisible in the K-corona.

British and German astronomers set up these long twin cameras, feeding light to them by a coelostat mirror in the shed. One of the large plateholders is seen at the extreme right. A small cloud frustrated this elaborate effort. American Museum-Hayden Planetarium photograph.

French astronomer A. Dollfus adjusts a coelostat at his eclipse site. Ceylon "Daily News" photo, courtesy Associated Newspapers of Ceylon, Ltd.

Near the same airstrip, two Indian teams established their camp. From Kodaikanal Observatory, 10 persons under Prof. A. K. Das brought along magnetic, ionospheric, and 200-megacycle radio equipment, as well as cameras to photograph the corona and spectrographs for the flash and coronal spectra. Dr. Vainu Bappu and two assistants from the Government Astronomical Observatory at Banaras planned to determine the polarization of the corona photographically.

Dr. J. Houtgast and N. van Straten, from Utrecht Observatory, Holland, set up a chromospheric spectrograph a few miles south of the Hingurakgoda airstrip. Departing from previous jumping-film chromospheric studies, they used a broad diaphragm to limit the light of the corona, and a narrow slit on part of the opening to determine precisely the part of the chromosphere being photographed.

Polonnaruwa. Here two very elaborate expeditions chose sites about four miles from the central line. Surrounded by stone ruins of the 11th-century Singhalese civilization, Prof. M. Waldmeier and his wife, from Zurich, Switzerland, and Dr. W. Petri, from Munich, Germany, set up 18 instruments designed primarily for a complete study of the corona. Prof. Waldmeier hoped that such a unified coronal program would yield a broad set of data from a single eclipse, eliminating the necessity of combining measurements from different eclipses for theoretical studies of the sun.

The Swiss group also brought four motion-picture cameras to make demonstration films of the eclipse. They found the strong winds of the locality undesirable, but solved the problem with hand-woven screens of palm leaves.

The nine-man expedition under Dr. M. Huruhata camped at a sugar farm, and erected nine buildings brought from Japan, including a workshop and a darkroom. Some of the University of Tokyo projects included a photoelectric survey of the little-known region between the outer corona and the zodiacal light, di-

Some of the equipment of the Kodaikanal Observatory's expedition at Hingurakgoda. Ceylon "Daily News" photograph, courtesy of the Associated Newspapers of Ceylon, Ltd.

The Japanese observers begin construction of their camp of nine buildings at Polonnaruwa. This is a Ceylon "Daily News" photograph, courtesy Associated Newspapers of Ceylon, Ltd.

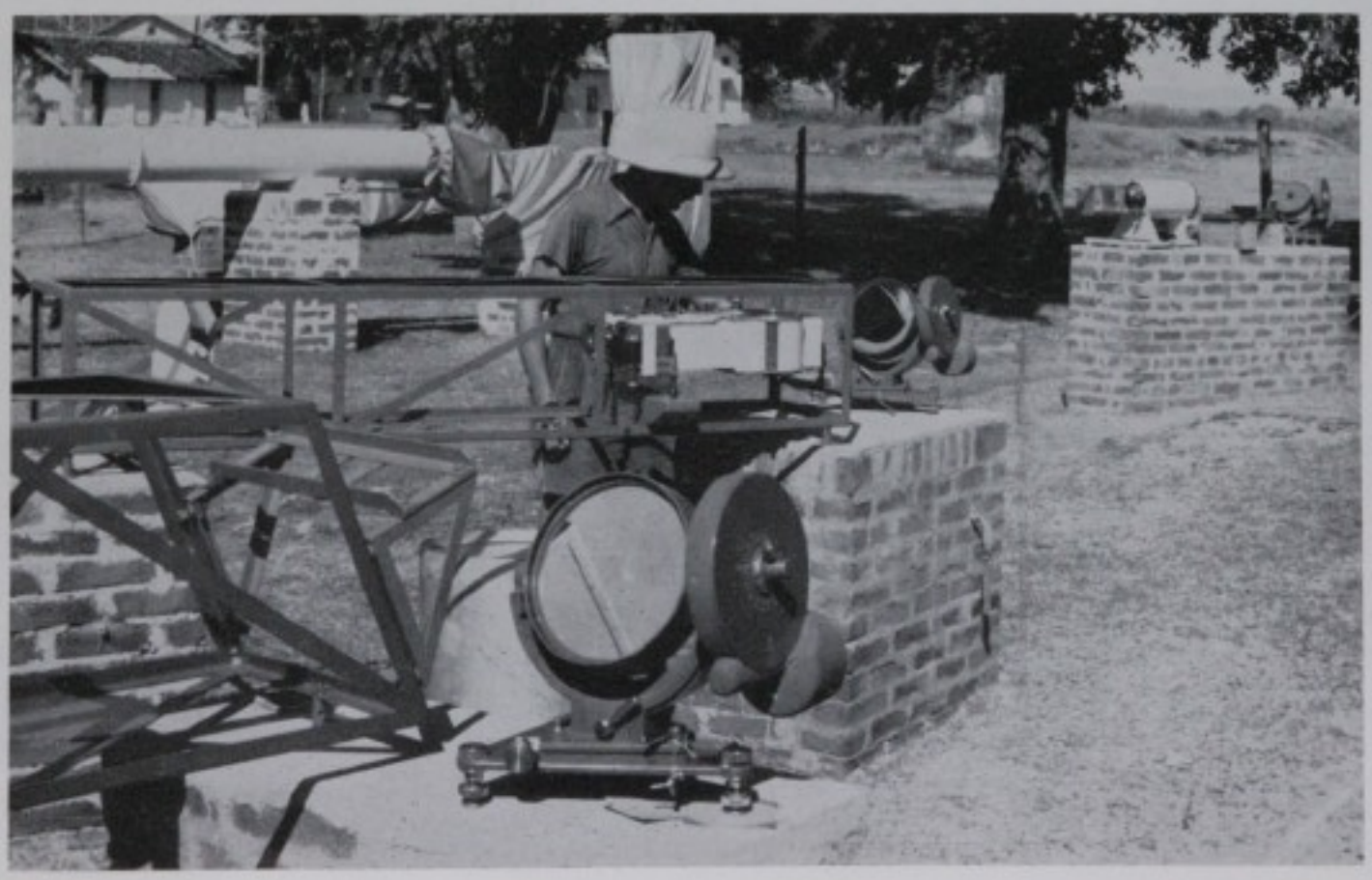
rected by Prof. Huruhata; measurements of the transition layer between the chromosphere and the corona, under Dr. Z. Suemoto; and a corona project similar to Dr. Dollfus'. F. Imagawa, of Kyoto University Observatory, planned movies of the flash spectrum using three cameras, recording different regions from the blue to the infrared.

An eclipse team from the University of London was located at the opposite side of the sugar farm. Prof. C. W. Allen proposed to measure the polarization of the outer corona, and his assistant planned to photograph the coronal spectrum. For this, the eclipse was to be enlarged artificially by an accurately placed diaphragm some distance from the spectrograph.

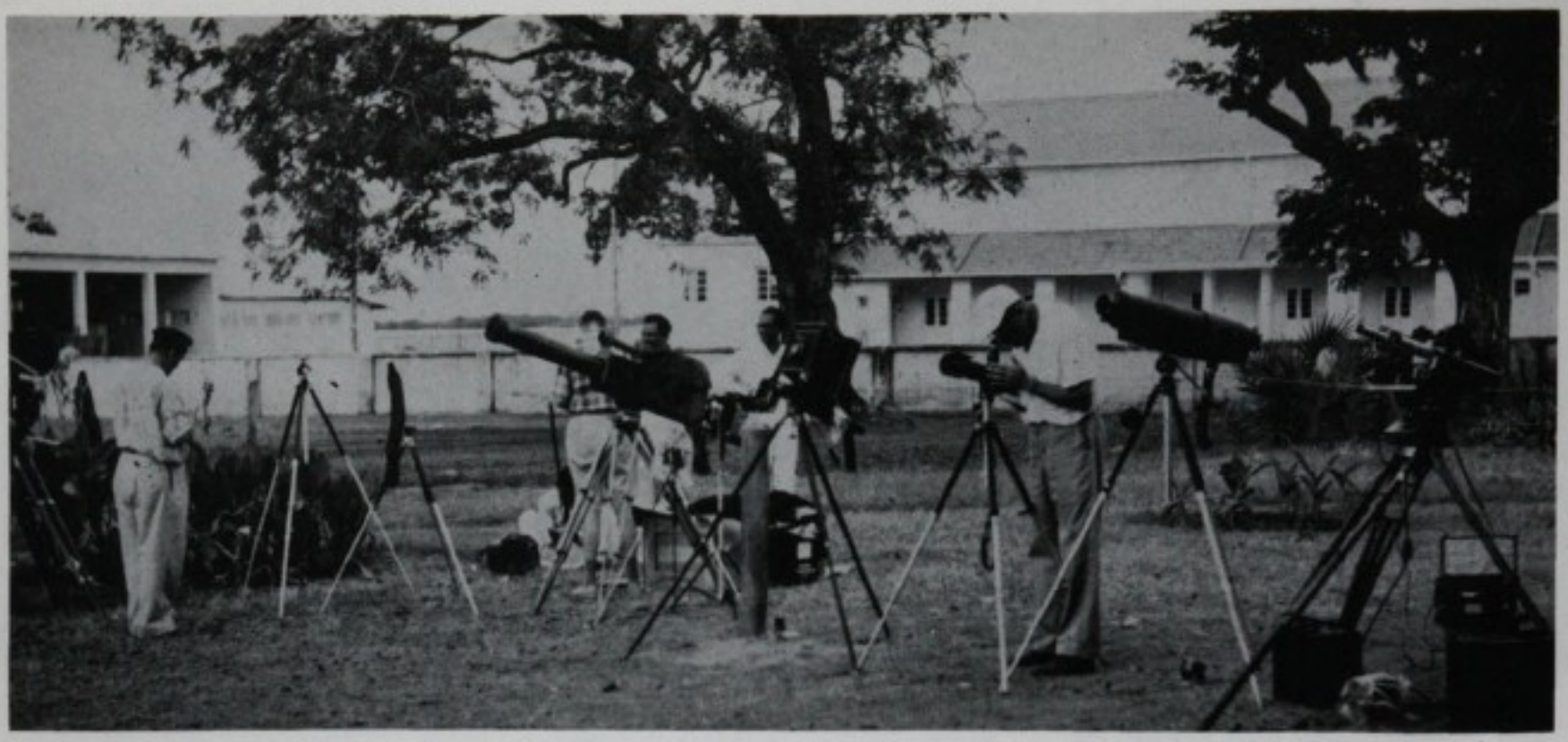
Sigiriya. Like the Swiss, the Harvard team in nearby Sigiriya found itself situated among old ruins, these dating to A.D. 500. While excavating for the telescope piers we struck an ancient brick wall. Expedition leader Dr. William M. Sinton and coauthor Owen Gingerich proposed to measure photoelectrically the brightness of the inner corona at six wave lengths from 3540 to 14,970 angstroms, using twin 5-inch telescopes in order to measure both the east-west and the north-south sectors of the corona. We used phototransistors and planned to record our data by making a movie of the output meters. With us was Dr. Harold Zirin, who was to photograph the infrared spectrum of the corona on Kodak I-N, I-M, and I-Z plates. He used a diffraction grating and a Speed Graphic camera with an Aero-Ektar lens, mounted on a separate pier (see page 452).

Trincomalee. Another American team, with Dr. Arthur Adel, director of the Atmospheric Research Laboratory, and Allen Gardiner, of Lowell Observatory, chose this site on the east coast. They hoped to measure bolometrically the radiation from the 9.6-micron band in the infrared spectrum of ozone, seeking to find changes in the concentration and temperature of the ozone layer at the zenith during the eclipse.

Batticaloa. A group of four from the American Museum-Hayden Planetarium, New York, composed of coauthor Joseph M. Chamberlain, Thomas D. Nicholson,



Elaborate preparations by the Swiss expedition were foiled by poor weather. Here Dr. Petri inspects his two-prism spectrograph. In the foreground is the coelostat for a single-prism spectrograph. At the upper right, on its own pier, is a 50-cm. camera. At the upper left is seen part of a camera of 26 feet focal length. Photograph, courtesy the "Times of Ceylon."



This array of still and motion picture cameras and telescopes was set up at the Hayden Planetarium-TWA site at Batticaloa. Personnel of both the Harvard and Hayden Planetarium expeditions were flown to Ceylon by Trans World Airlines. American Museum-Hayden Planetarium photograph.

and two photographers, planned to produce a documentary film of the eclipse and the research being undertaken by the American and other expeditions. Our equipment included two Cine-Kodak 16-mm. tandem-mounted cameras, both with 6-inch lenses, one with time-lapse mechanism to be operated at one frame per second, the other with motor drive for filming the particularly interesting phenomena at second and third contacts at speeds up to 64 frames per second. For color slides of the eclipse, we had two cameras with telephoto lenses, one of 25 and the other of 69 centimeters focal length.

Agnew Fisher, director of motion pictures for TWA, worked with our group, and another observer at Batticaloa was Ralph S. Damon, president of TWA.

Peradeniya. A second Japanese expedition, under the direction of Prof. Y. Kato, chose the University of Ceylon for their site. This was a geophysical expedition, and the rainy climate of the Kandy region did not affect their measurements of the earth's magnetic field.

The Kyoto Observatory equipment included three cameras for the flash spectrum. Note the tilt given the base of the mounting to compensate for the low latitude of Ceylon. American Museum-Hayden Planetarium photo.

As eclipse day approached, several astronomers became very pessimistic about the weather. Prof. von Klueber noted that in the previous three months only four days would have been good enough to perform the Einstein deflection observation. The week before the eclipse had been particularly bad, as the monsoon conditions seemed to spill over into the normally dry regions.

On eclipse morning, there was general cloud cover over almost all of Ceylon. At Polonnaruwa, the first partial phases were visible through scattered clouds, but a few minutes before totality a stubborn cloud seemed to defy the wind and stay put directly in front of the sun. At Hingurakgoda totality was completely obscured.

At Sigiriya the clouds were lighter, and hundreds of people on the huge Sigiriya Rock or around the Harvard expedition site witnessed a beautiful total eclipse. Scientifically, however, the thickness and irregularity of the clouds prevented any color measurements. For a while, partial success seemed within our grasp, for enough light was available to expose the infrared spectrum plates, but these were fogged by the bright cloudiness and contain no emission lines.

Expeditions on the east coast were also clouded out, except for a Ceylon government unit and various amateurs who successfully observed from Kalkudah and a few coastal points just north of it.

In the eastern hill country of Ceylon, U. S. Ambassador Philip K. Crowe ob-

(Continued on page 466)

At Hingurakgoda the sun was clouded out exactly eight seconds before totality and remained so until four minutes after, according to Dr. Vainu Bappu, who sent this picture. The half-second exposure was made on the very first occasion the sun became visible. Uttar Pradesh eclipse team photograph.

Members and guests at the ninth general convention of the Astronomical League, on the campus of the University of Washington in Seattle, July 1-4, 1955.

AMATEURS CONVENE AT SEATTLE

EARLY IN JULY the Astronomical League held its ninth general convention at Seattle, Wash., the first time it has met in the Northwest Region. Representatives came from all parts of the United States: the District of Columbia, Florida, Georgia, Illinois, Massachusetts, Michigan, Mississippi, Missouri, New York, Pennsylvania, Texas, Virginia, and Wisconsin, as well as from the Northwest. The official registration was 146.

Laurels for the longest trip to Seattle went to Lynn H. Collar, from Miami, Fla., where the 1956 general convention will be held. A highlight of the closing session this year was Mr. Collar's talk on the activities of Florida amateurs, and his motion picture showing the attractions awaiting delegates at Miami next summer.

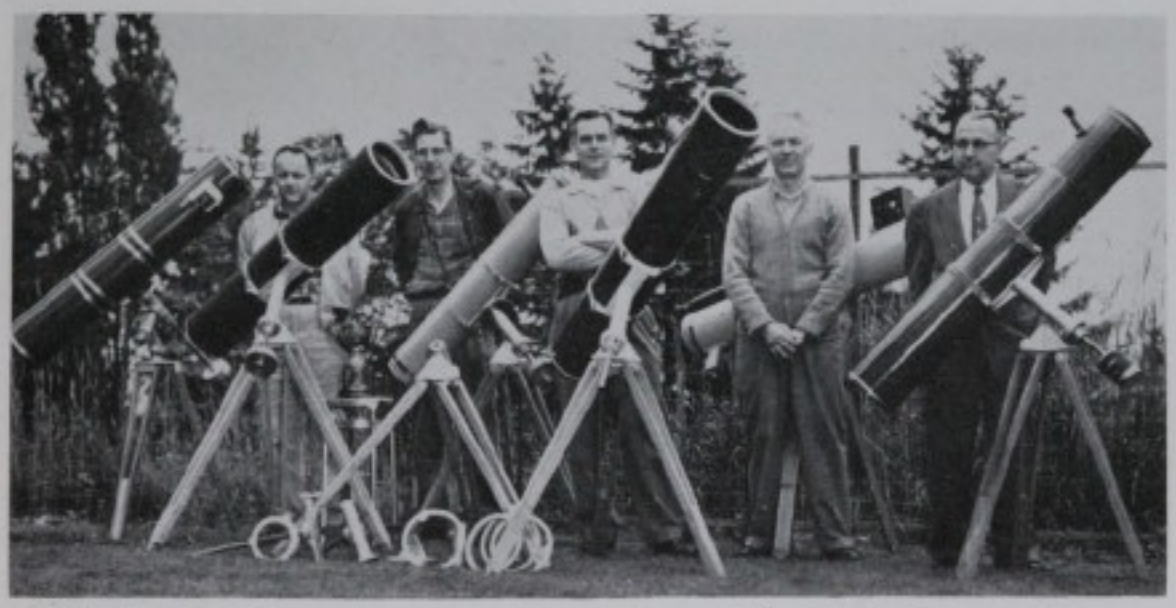
The Northwest Region was organized in November, 1947, as the third in the league. At that time it comprised only three societies, two in Portland, Ore., and one in Yakima, Wash. Yet this nucleus of organized amateurs supported league activities and encouraged the formation of other societies. The region now also includes member groups in Spokane and Tacoma, as well as the Seattle Amateur Astronomical Society, which in 3½ years of existence has attained a membership of over 100, and on this occasion was the host society.

Guy R. Blackie, president of the Seattle group, at the instruments session on July 2nd described the local activities and projects. The society has been given a 99-year lease on an acre of ground at Beaver Lake, about 25 minutes drive outside the city. To provide for consistent policies during the construction years, it set up a permanent board for the administration of the Beaver Lake Observatory. The amateurs themselves built the building, which will house the 12-inch telescope procured two years ago, and the project is proceeding steadily.

There are 15 members in the local telescope making group, and 12 mirrors are being completed. Most of these will be mounted on castings of a standard equatorial head developed by Mr. Blackie and Howard G. Anson.

Other notable amateur observatories in the Seattle area are those of Mr. Blackie himself and of William B. King. On Sunday evening these were open for inspection and observing. The first houses two 8-inch reflectors on one mounting and the other a 6-inch. Unfortunately, skies were too cloudy for observing, but technical discussions filled the evening.

At the instruments session, Mr. King described in detail the process of procuring, bending, cutting, lapping, and sealing the segments that make up his dome. On the stage of the auditorium



The first six telescopes completed by members of the Seattle Amateur Astronomical Society, shown here, were all exhibited at the convention. Mr. Blackie is second from the right. Photograph by Eddy Mannery.

in Guggenheim Hall, University of Washington, where the sessions were held, Mr. King demonstrated the joining and sealing process, and illustrated his talk with photographs and blackboard diagrams.

On Friday and Saturday evenings, the program was highlighted by addresses by two professional astronomers of the Northwest. Dr. T. S. Jacobsen, head of the astronomy department at the university, illustrated his talk on pulsating stars with some unusual colored slides. He spoke especially about the Cepheid variables Eta Aquilae and Delta Cephei, following their histories step by step, and considering the rise and fall in favor of two rival theories: that the Cepheids are pulsating single stars, and that they are binary stars. The first is widely accepted at present, but the second, Dr. Jacobsen said, explains much of the observational evidence satisfactorily.

Cepheid pulsation may be supported by a shock wave that originates in the interior of the star, possibly when the star has contracted the most—the resulting high pressure raises the internal temperature and causes a great increase in the liberation of energy. Dr. Jacobsen, who has observed Cepheid spectra with the large telescopes on the West Coast, described what appear to be bright calcium flashes in the spectrum of Eta Aquilae. These may be caused when the shock wave, only a few kilometers thick, passes through the atmosphere of the star.

As banquet speaker on Saturday evening, Dr. R. M. Petrie, director of the Dominion Astrophysical Observatory, discussed the measurement of stellar distances, which he called one of the most difficult problems in astronomy today. He pointed out that none of the bright stars of spectral type *B* is near enough for its distance to be determined by the direct trigonometric method. Among 1,600 stars within 100 light-years of the sun there are no *B* stars.

Thus, to determine *B*-star distances, we must find their individual absolute magnitudes; then their distances can be determined from the relation between absolute and apparent magnitudes. In 99 typical *B*-type stars, Dr. Petrie has found a close relation between the intensity and shape of the hydrogen absorption lines and the absolute magnitudes, which range from zero to −7, that is, from 100 to 60,000 times as bright as the sun. By means of these hydrogen line characteristics, Dr. Petrie has finished a preliminary survey of the distances of 400 *B* stars, and he is now working on 1,000 more. This work is fundamental in establishing the detailed structure of the Milky Way, as the *B* stars can be seen at great distances because of their high luminosities.

Presentation of the Astronomical League award was made at the banquet to Carl P. Richards, of Salem, Ore. An engineer who has been an active amateur astronomer for many years, Mr. Richards is widely known through his writings, his correspondence with fellow amateurs, and his astronomical photography. He successfully observed the total eclipses of 1945, from Wolseley, Sask., and 1954, from Minneapolis, Minn. He has attended many conventions of the Astronomical League, has served for years on its council, and has been treasurer and vice-president.

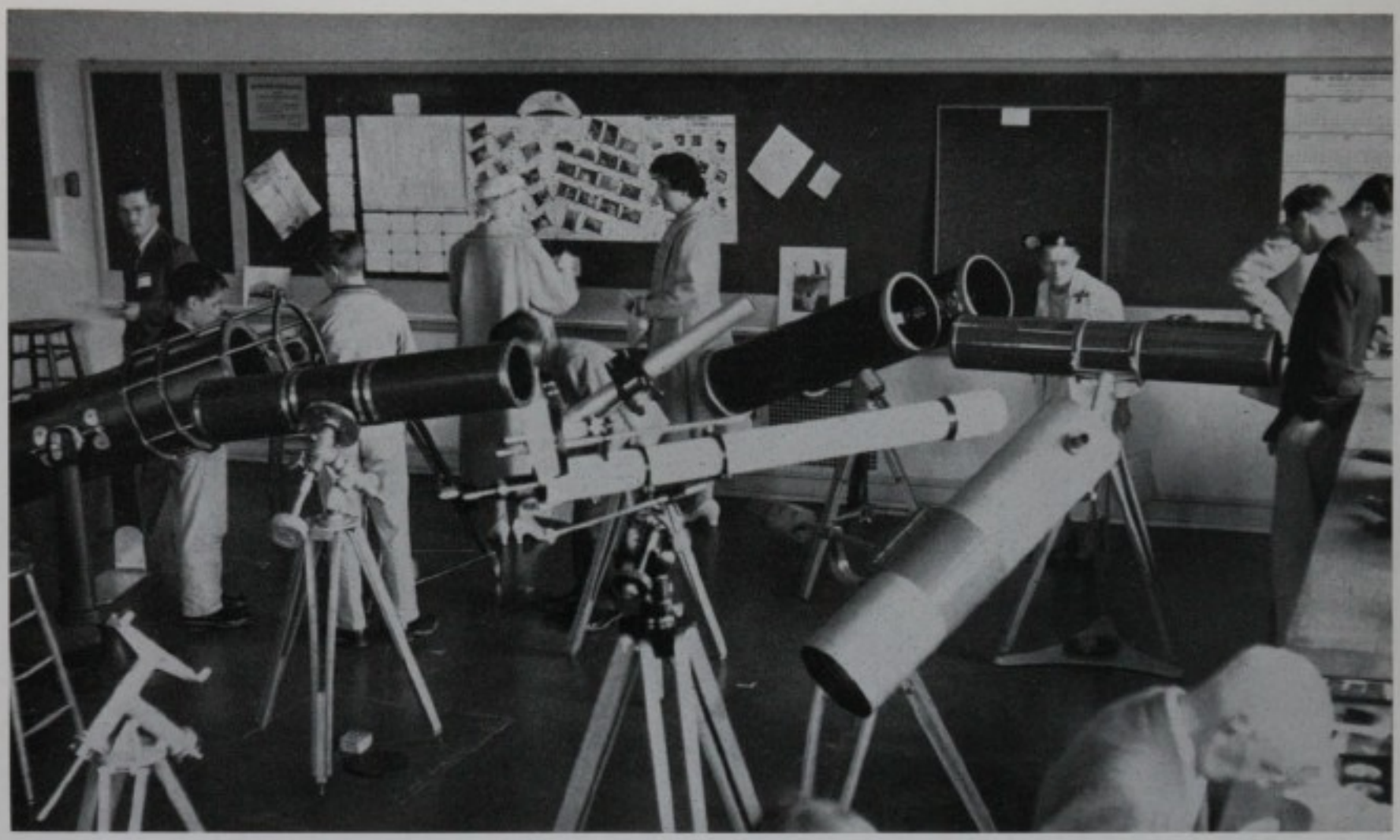
Carl P. Richards, of the Portland Astronomical Society, was recipient of the Astronomical League award for this year.

An unexpected contribution to the program was a description of solar eclipse observing on June 20th by Mr. and Mrs. George A. Kovaka, Pacific, Mo., and Robert H. McDowell, Portland, Ore., who went on the eclipse tour announced in the January *Sky and Telescope*. They observed successfully from the garden of the Manila Hotel. They appear in the picture on page 449.

The encouragement of astronomy as a hobby for juniors is becoming increasingly important in the Astronomical League. A decade ago, when the league was formed, there were only a few active junior groups in the country. Now there are several score. Clarence H. Johnson, Schenectady, N. Y., chairman of junior activities of the league, is planning a brochure for adult amateur leaders to assist them in sponsoring junior astronomy groups. He pointed out that within 24 groups reporting to him, juniors had built a total of 19 telescopes, and had 435 more available for observing. In addition to their normal activities with variable stars, meteors, sunspots, and the like, some juniors are concentrating on celestial photography, and some regularly give instruction in astronomy and constellation study at summer camps.

The junior session included 12 papers. Needing money to buy parts for the telescope he was making, Lewis Macfarlane, a Seattle high school student, decided to give six lectures on popular astronomy. He typed circulars and distributed them

A group of Astronomical League officers at the convention, left to right: Mrs. Wilma A. Cherup, Pittsburgh, Pa., executive secretary; Chandler Holton, Atlanta, Ga., treasurer-elect; James H. Karle, Portland, Ore., president; and Grace C. Scholz, Alexandria, Va., president-elect.



This is part of the convention exhibit, where a great variety of telescopes was on display. Seen at the right of center are twin reflectors mounted together to form a huge binocular telescope.

to people in his neighborhood. The talks were given in his back yard when the weather was favorable; each member of the audience paid a small admission fee. His subjects were the sun (daytime); the moon (at first quarter, 26 persons attended); the solar system (Mars and other planets were observed); stars and constellations; color in the sky (postponed one night for rain); and the layout of the universe (observed clusters, M31, and the Ring nebula). The telescope paid for by these activities appears on the front cover. For news of Mr. Macfarlane's recently found comet, see page 447.

Kay Gross, president of the Ft. Worth advanced junior section, has visited 19 observatories and five planetariums, and attended the Dallas and Washington, D. C., conventions of the Astronomical League.

Now 11 years old, Bruce Maston told how two years ago he had read of the Seattle society in the local newspapers. He attended a meeting and enjoyed it; he now is very active, and has a 6-inch telescope.

At the final session Sunday, retiring president James H. Karle, of Portland, Ore., introduced the new officers. President for the coming year is Grace C. Scholz, Alexandria, Va., who for many years was executive secretary and now conducts the league book service. Re-elected as vice-president is Russell C. Maag, Sedalia, Mo., and as secretary Joseph A. Anderer, Chicago, Ill. The treasurer will be Chandler Holton, Atlanta, Ga.

Formation of the Great Lakes Region has been approved, to include Kentucky, Ohio, Indiana, and lower Michigan (formerly part of the Middle East Region). Only seven states are now outside the borders of established regions.

The council of the league held many conferences, including this one late on Saturday evening, July 2nd. The council is made up of the national officers, the regional chairmen, and a representative from each region.

It is to be hoped that at Denver on September 9-11 (see page 465), a Rocky Mountain region of the Astronomical League will be organized. The states of California, Nevada, and Arizona are at present covered by the Western Amateur Astronomers, which held its convention this year at Yosemite National Park in August.

Astronomical League activities are increasing. Mrs. Wilma A. Cherup, Pittsburgh, Pa., executive secretary, reported 75 member organizations, of which 11 include juniors, 13 junior member organizations, 31 individual members-at-large, two affiliate societies (the American Association of Variable Star Observers and the Association of Lunar and Planetary Observers), and seven supporting commercial organizations.

The concluding feature of the Seattle convention was a field trip on July 4-5, to the Dominion Astrophysical Observatory, near Victoria, B. C., with 63 persons going. Delegates traveled in two buses, crossed to Vancouver Island by ferry, stayed overnight in Victoria, and returned via the city of Vancouver, B. C.

It was rather cloudy, but visitors had opportunity for a few views through the 73-inch reflector. They thoroughly inspected the telescope and the observatory. Dr. Petrie not only gave an illuminating talk on the past history and future plans of the observatory, but stayed far into the night answering questions.

Edward J. Newman, of the Yakima Amateur Astronomers, is editor of the Yakima "Observer," now in its 16th volume. He has been active in affairs of the Northwest Region.

Nonastronomical excitement was provided by the fact that one of the charter buses lost its reverse gear at the observatory and couldn't negotiate a sharp hairpin turn on the way down. Most of the people on the bus got out and pushed it back far enough to make the turn—but to no avail. At the bottom of the hill the engine died and couldn't be restarted. The other bus took its load into Victoria, and returned for the stranded passengers.

C. A. F.

ROTATION OF NEPTUNE

Neptune has an appreciably shorter rotation period than the 15.8 hours found spectrographically by J. H. Moore and D. H. Menzel in 1932, states Dr. O. Guenther, Muenster Observatory, Germany. He has analyzed photographic brightness measurements by J. Brouet in 1932, and from these finds the Neptunian day to be 12 hours 43.5 minutes.

He notes that Moore and Menzel used too large a diameter for Neptune; allowing for this reduces the spectrographic rotation period to 14.1 hours, with an uncertainty of one hour.

☆ ☆ *SKY AND TEACHER* ☆ ☆

Sponsored by the
Teachers' Committee of the American Astronomical Society

COLLEGE PROGRAMS FOR ASTRONOMY MAJORS

IN ADDITION to the data on college astronomy reported here in July, the recent survey by the Teachers' Committee revealed that a major program in astronomy is offered at some 35 colleges and universities in the United States. At several other institutions the student may concentrate in a combined program of mathematics and astronomy, or in physics and astronomy.

Reference to the course catalogues of the 35 institutions indicates the typical program of a college student who majors in astronomy. Along with required courses in other disciplines, he will fulfill several premajor requirements in his first two college years. These usually include a one-year course in basic descriptive astronomy, one year of general college physics, and mathematics through trigonometry and analytic geometry up to or including beginning calculus.

In the third or junior year, the astronomy major will begin to specialize in his chosen field of concentration. He must take four or five one-semester courses in advanced astronomy, although this rule varies from one college to another, depending on the size of the astronomy staff and the number of such courses offered.

At many colleges, a student must also choose a minor subject of specialization. The minors most relevant to an astronomy major are mathematics and physics, although chemistry, geology, and philosophy are occasionally listed as acceptable minors. Where minors are not required, it is ordinarily specified that along with advanced astronomy courses one must complete in the upper-class years a study of the calculus and perhaps of beginning statistics. Sometimes, and especially where only a few astronomy courses are offered, the student is asked to study certain second-year physics courses, such as optics and atomic physics.

The advanced astronomy courses go by a variety of names in the catalogues, but their content is rather uniform from one school to the next. A typical group of offerings is this: a one-semester or two-semester course in observational or practical astronomy, treating the theory and use of astronomical instruments; one or two semesters of introductory astrophysics; a one-semester course in celestial mechanics and planetary orbits. Several institutions offer a course in the structure of our galaxy; most of the remainder include this subject in the domain of astrophysics. Others have fairly all-embracing courses called advanced general astronomy or mathematical astronomy. These usually run for two semesters, and illustrate the application of physical principles and mathematical techniques to the solution of a wide variety of astronomical problems.

Of the 35 institutions offering the strictly astronomical major, 17 are large universities with total enrollments above 5,000, four are medium-sized, and 14 are small colleges with less than 2,000 students. Of the whole group there are 15 state or municipal universities and 20 private institutions. Five are women's colleges, six are men's colleges, and 24 are coeducational.

Geographically, six of the 35 schools are in the Far West (Arizona and California); five are in Kansas, Oklahoma, and Texas; nine in the Middle West; one in the South (Virginia); and 14 in the Northeast. Massachusetts has seven colleges offering a major in astronomy; California ranks second, with five.

Finally, it should be stressed, for the benefit of the young person who may be contemplating a career in astronomy, that an undergraduate major in astronomy is not at all a requirement for admission to one of the graduate schools for a master's or doctor's degree in astronomy. A student living several hundred miles from any of these 35 institutions may prefer while an undergraduate to live close to his home or to take advantage of the lower in-state fees at his home-state university. If he does this he will ordinarily major in physics or mathematics, enrolling in whatever astronomy courses there are available.

STANLEY P. WYATT, JR.
University of Illinois Observatory

NEWS NOTES

By Dorrit Hoffleit

THE LUNAR ATMOSPHERE

In recent years, several estimates have been published on the density of the moon's atmosphere. For example, Russian astronomers have reported values as high as 1/20,000 to 1/12,000 of the terrestrial atmospheric density. However, polarimetric observations by A. Dollfus in France showed no indication of a lunar atmosphere, and gave a density of 10^{-9} of our atmosphere for an upper limit.

Dr. E. J. Opik points out, in the *Irish Astronomical Journal*, a simple visual observation that disproves the high atmospheric density proposed by the Russian authors. Their conclusions would require a lunar twilight that would extend the horns of the lunar crescent by some five or six minutes of arc, and be some 50 times brighter than earthshine at quarter moon.

Such twilight prolongations of the horns are not observed, and Dr. Opik verified from his own observations that the lunar twilight could not have been one quarter as bright as the neighboring earthshine. From this he deduces that the density of the lunar atmosphere cannot be greater than one part in 1.3 million of the terrestrial atmosphere.

PREHISTORIC DRAWINGS OF A SUPERNOVA?

Two similar prehistoric pictographs found in the wilderness of northern Arizona during surveys by the Museum of Northern Arizona have been interpreted as possibly representing observations of the supernova of 1054. This is the supernova from which the Crab nebula is believed to have been formed.

One drawing is in a cave in the White Mesa, the other on a canyon wall associated with ruins on a tributary of Navaho Canyon. Both show a crescent with a circle of smaller diameter nearby and below. Assuming that the crescent represents the moon, Dr. William C. Miller, of Mount Wilson and Palomar Observatories, points out that some unusual apparition was depicted, for the crescent shape is rare in the prehistoric drawings found in northern Arizona. Dr. Fred Hoyle, of Cambridge, England, suggested that the pictures might represent a conjunction of the moon with the supernova of 1054.

Computations revealed that the moon was a crescent in the morning sky on July 4, 1054, the date when the supernova flared up, and on July 5th was two degrees directly north of the star. From Japanese and Chinese records, it is known that the supernova was about magnitude −5, several times as bright as Venus. It must have formed a very striking spectacle with the crescent moon.

Were the two sites at which the drawings were found occupied in 1054? Archeological studies of pottery fragments at White Mesa were indecisive, but the Navaho site yielded numerous fragments, many from the 10th and 11th centuries. Circumstantial evidence, therefore, supports the belief that the pictographs represent the supernova of 1054. If this is correct, they are the first observations of the outburst discovered outside the Orient. Dr. Miller's account of the drawings appeared in *Leaflet* 314 of the Astronomical Society of the Pacific, July, 1955.

SOLAR RADIO TELESCOPE

By early 1956, an unusual radio telescope will be put into operation by Harvard Observatory astronomers on Sacramento Peak, N. M., at the Upper Air Research Observatory of the Air Force Cambridge Research Center. First instrument of its type in the United States, the telescope will measure radio emission from sunspots and other active regions on the sun.

The new instrument will have an equatorially mounted parabolic reflector 28 feet in diameter. This will feed sensitive receivers that will scan 10 times each second the frequency range from 100 to 600 megacycles (corresponding to wave lengths of 3 to 0.5 meters).

Dr. Alan Maxwell, formerly of the Jodrell Bank Experimental Station near Manchester, England, will be the astronomer in charge of the instrument.

EDISON PETTIT RETIRES

An astronomer particularly noted for his work on solar prominences, Dr. Edison Pettit retired on July 1st from the staff of Mount Wilson and Palomar Observatories. He had joined the staff of Mount Wilson Observatory in 1920, after receiving his doctor's degree from the University of Chicago.

Dr. Pettit was the first to study the ultraviolet radiation of the sun to the limit of atmospheric transmission. He also developed sensitive vacuum thermocouples, which he and Dr. Seth B. Nicholson used to measure heat radiation from stars, planets, and the moon. Shortly before his retirement, he completed a long series of photoelectric measurements, begun in 1947, of the brightnesses and colors of galaxies—data important in the problem of the expanding universe.

CANADA'S FIRST OBSERVATORY

At a formal ceremony on May 10th, a plaque erected by the Canadian Historic Sites and Monuments Board was unveiled to mark the first astronomical observatory in Canada, at Fredericton, N. B., on the campus of the University of New Brunswick. This observatory was built in 1851, at the instigation of Prof. William B. Jack, who was active in geodetic work, and who corrected errors in the boundary between the United States and Canada.

IN THE CURRENT JOURNALS

IS LIFE POSSIBLE ON OTHER PLANETS? by G. A. Tikhov, *Journal*, British Astronomical Association, April, 1955. "I believe that the data cited are quite sufficient to consider the extreme dryness of the Martian atmosphere no obstacle for the existence of plants."

RADIOACTIVITY IN GEOLOGY AND COSMOLOGY, by Truman P. Kohman and Nobufusa Saito, *Annual Review of Nuclear Science*, 1954. "Completely independent and fairly precise estimates of the 'age of the universe' and of the 'age of the elements' would be highly desirable, in order to determine whether or not they are indeed identical."

INSIDE THE EARTH, by J. A. Jacobs, *Journal*, Royal Astronomical Society of Canada, May-June, 1955. "It is probably true to say that many scientists and most people would feel more at home in discussing atoms and atomic structure, the planets, the stars and even the galaxies than they would in discussing the conditions that exist under their own feet. . . . Geophysics is a young science, however, and considerable advances have been made during the last few years."

AN ORIENTATION TOWARD MODERN PHYSICAL THEORY, by Marshall J. Walker, *Scientific Monthly*, July, 1955. "The aspects of general mechanics most directly useful in macrophysics are studied in the restricted and general theories of relativity. The aspects of general mechanics most directly useful in microphysics are studied in *quantum mechanics*. These will be considered in order. . . ."

UNIFICATION OF ALMANACS

Since 1912 the basic calculations required for astronomical ephemerides have been freely interchanged between the principal ephemeris offices, to reduce duplication of calculation; and in 1941 the international volume, *Apparent Places of Fundamental Stars*, was introduced under the auspices of the International Astronomical Union, to reduce duplication in printing. Each of the countries concerned in this interchange has continued to print its own almanac, containing virtually the same data; a fully international astronomical ephemeris is not as yet possible, partially because of the language difficulty.

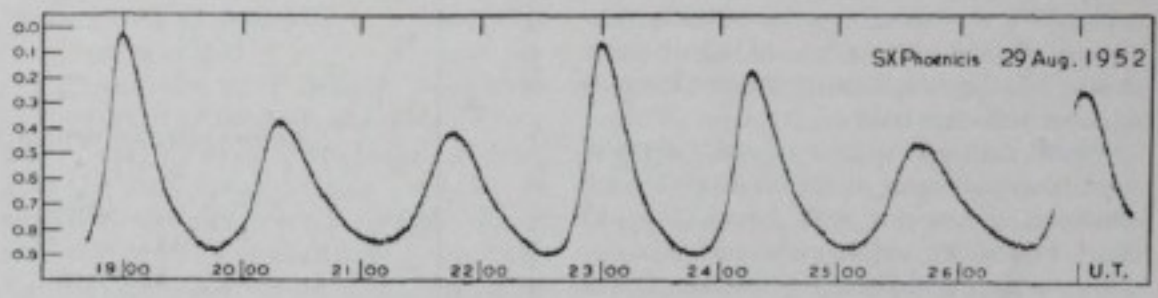
However, agreement has now been reached for the unification of the *American Ephemeris and Nautical Almanac* and the British *Nautical Almanac*. With the exception of a short introduction, the almanacs will be identical beginning with the volumes for 1960. They will be printed separately in the two countries from reproducible material prepared partly in the United States and partly in the United Kingdom. This material will also be made available to the ephemeris offices of other nations.

Some Unusual Short-period Variables

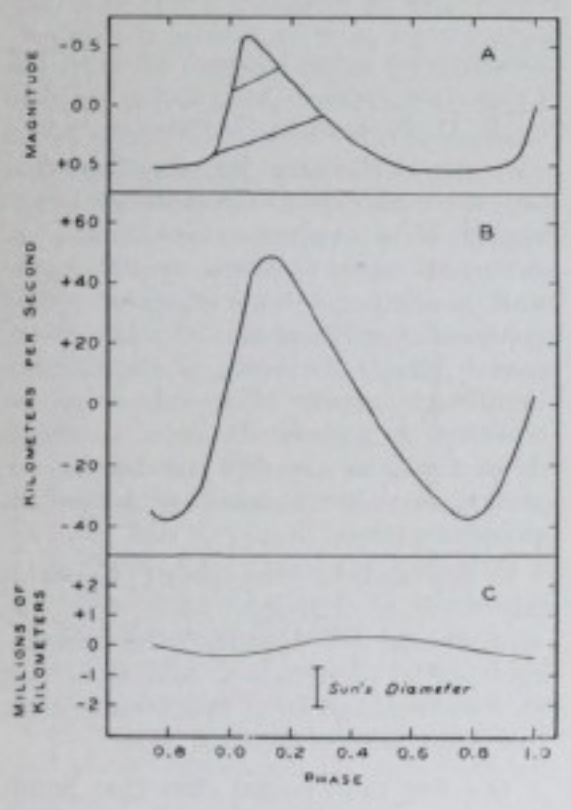
OTTO STRUVE, *Leuschner Observatory, University of California*

THE PULSATING variable star AI Velorum, described last month, has a remarkable behavior: Its light curve, which daily runs through nine cycles of varying form, can be disentangled into no fewer than six superimposed periodicities. The star pulsates simultaneously in periods of 161 and 124 minutes, giving rise to a nine-hour beat period, and there are also three periods of minor oscillations. Each type of pulsation contributes to the light curve, giving it a complexity that was unraveled only by the penetrating analysis of T. Walraven, of Leiden Observatory.

A similar variable, SX Phoenicis, was discovered by the Lick Observatory astronomer, O. J. Eggen, working at the Commonwealth Observatory in Australia. (See page 112 of the March, 1952, issue.) While not so thoroughly observed as AI Velorum, SX Phoenicis shows similar traits. Its principal period—the shortest known for any variable—is only 79 minutes. As with AI Velorum, the beat period is about 3½ times longer. The light curve can be resolved into two components that interfere to produce the beat period. Again, we can assume that the original oscillations are simple sine curves, and their combination is then subject, as in AI Velorum, to the same S and M distortions explained last month.



A photoelectric tracing of the complex light variations of SX Phoenicis, the cluster-type variable with the shortest known period, as observed by T. Walraven. From the "Bulletin" of the Astronomical Institutes of the Netherlands.



Three aspects of the variability of RR Lyrae, according to Joel Stebbins. In A is shown the photoelectric light curve, with magnitude changes counted from an arbitrary zero. The transverse lines connect points on the light curve where the variable had the same color. The curve in B indicates the rate of change of the star's radius, positive rates indicating expansion. Panel C shows the radius of the star, at different phases, expressed as a difference from the average radius. The horizontal scale for the chart is in fractions of the variable's period. Adapted from the "Publications" of the Astronomical Society of the Pacific.

The radial velocity changes with an average range of about 40 kilometers per second, according to unpublished observations by O. C. Wilson at Palomar Observatory.

Both stars resemble RR Lyrae in their behavior. Walraven has shown that in this star the principal period, of about half a day, is accompanied by a first-overtone period of about one-quarter day. These are coupled to produce a third period, which interferes with the primary one to cause a beat period of 41 days. Furthermore, the first and second overtones (the latter is not observed) interact to give another period that is only slightly shorter than the principal one. Again, the observed light curve is a summation of harmonic oscillations that are disturbed by the S and M distortions.

RR Lyrae is itself the prototype of the RR Lyrae variable stars. Its radial-velocity curve has been determined; hence we can compute, in kilometers, how much larger or smaller than average its radius is at any instant.

Consider a pair of points on its light curve, one on the ascending branch where the star is growing brighter, one on the descending branch. If we select these points so that the colors—and hence the temperatures—are the same, we find that the magnitudes are not the same. This discrepancy in brightness is caused by a difference in the size of the star at these two phases. J. Stebbins has chosen such pairs of points from his photoelectric observations of RR Lyrae.

For instance, for one pair he finds that the radii differ by 330,000 kilometers when the color is the same; the larger radius is $R + 330{,}000$ if we call the smaller R. The areas of the stellar disk at these two times are therefore in the ratio $(R + 330{,}000)^2/R^2$, and this must equal the brightness ratio, 1.117, that corresponds to the observed magnitude difference of 0.12. We can solve the resulting equation to find that the smaller radius is about 6,000,000 kilometers, or some eight times the sun's.

From this, we can estimate the absolute magnitude of RR Lyrae. Its spectral type averages about *F0*, and hence its temperature is roughly 7,500°K. The temperature of the sun's surface is 6,000°, giving a ratio of 1.25. By Stefan's law, the radiation per unit area of a star is proportional to the fourth power of its temperature. Every square centimeter of the surface of RR Lyrae emits about 2½ times as much light as an equal area on the sun, and the star has eight times the diameter of the sun. Therefore, RR Lyrae is well over 100 times brighter than the sun, which corresponds to a difference of about five magnitudes. The solar absolute magnitude is about +5, and therefore the absolute magnitude of RR Lyrae is zero. This estimate agrees closely with the more precise calculations by Stebbins and by W. Becker.

The same value of zero comes from statistical studies of the proper motions of RR Lyrae (true cluster-type) variables in the Milky Way, and from studies of such stars in globular clusters and in other galaxies.

Yet it is certain that SX Phoenicis has a much lower luminosity than RR Lyrae. Its spectrum, about *A5*, has been described by A. H. Joy and G. P. Kuiper as that of a subdwarf. It must therefore

fall below the main sequence, at perhaps absolute magnitude +3. If we use the trigonometric parallax of this star, as H. J. Smith has recently done in his study at Harvard of short-period cluster-type variables, we find even +3.9. Both Walraven and Smith raise the question of whether SX Phoenicis, and other short-period variables that are considerably less luminous than absolute magnitude zero, may not form an entirely new group of pulsating stars, of which only a few of the brightest members have so far been discovered.

Smith makes it appear virtually certain, from computations of radius like the one outlined above for RR Lyrae, that at least two other well-known variables belong to this group. CY Aquarii, with a period of 1½ hours and a spectral type of *A*4, is 3½ times smaller than RR Lyrae, and its absolute magnitude is +2.5. VZ Cancri, with a 4.3-hour period and an *F*1 spectrum, has an absolute magnitude of +0.7. Smith is inclined to include AI Velorum, but Walraven doubts this.

There is some reason to believe that the *F*1 star, Delta Scuti, with a period of 4.7 hours, also belongs to this group. From its rather uncertain parallax Smith derives an absolute magnitude of +1.6. But the spectrum is that of a giant, and this would make the absolute magnitude more nearly zero (the value used in the diagram). Also, we should include here M. Walker's recent discovery, DQ Cephei, whose period is two hours and spectral type *F*1. From the appearance of its spectrum, its absolute magnitude may be estimated as +2.0, and the radial velocity varies with a range of 12 kilometers per second. Still another representative is the star BD +41°119, for which Eggen and P. O. Lindblad found a period of three hours. Its spectrum is *F*, but the absolute magnitude is not known.

Such stars Smith calls *dwarf Cepheids* (see *Sky and Telescope*, June, page 321). He summarizes their properties as follows:

1. The periods are usually shorter than 0.2 day (compared to around half a day for most of the true RR Lyrae stars) and the spectral types are *A* or *F*. Their absolute magnitudes average +2, much fainter than for RR Lyrae stars, compared with which they are smaller and denser.

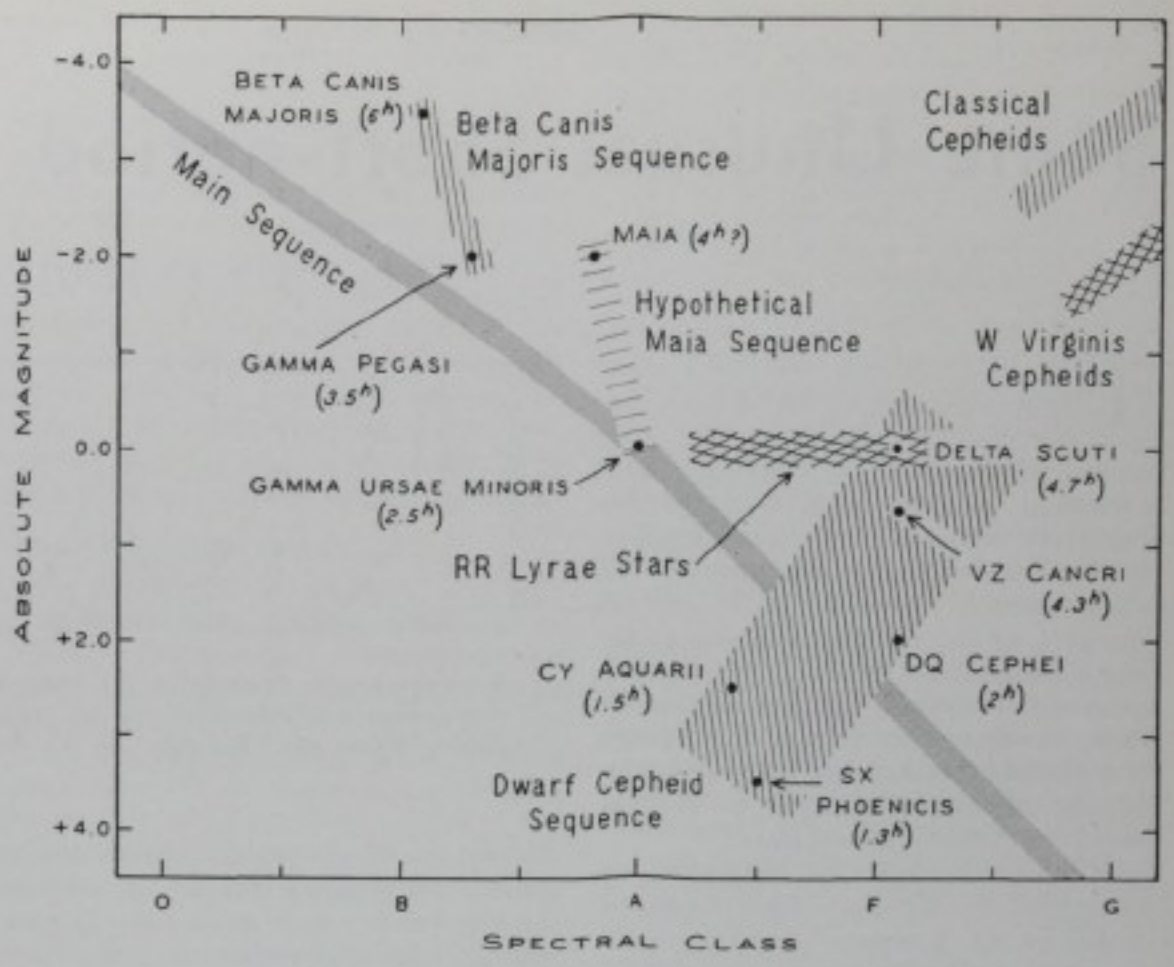
2. When spectra are plotted against periods, the dwarf Cepheids form a line parallel to that of the RR Lyrae variables, but displaced toward shorter periods. There is a very pronounced period-luminosity relation. The range in brightness of the dwarf Cepheids is largest, about one magnitude, for those of shortest period, and diminishes for variables of longer period.

3. The motions of these variables indicate that they are not true high-velocity stars and are more closely affiliated with Population I than II. Their average drift velocity relative to the sun is only 66 kilometers per second, as against 163 kilometers a second found for true RR Lyrae stars (periods longer than 0.4 day) by E. D. Pavlovskaya in Moscow.

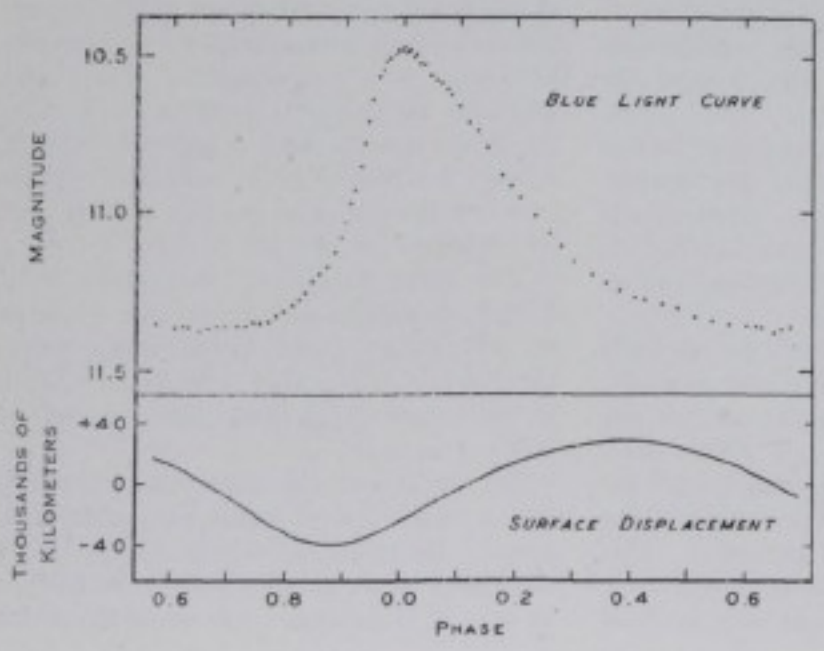
4. After allowing for the fact that only the nearer dwarf Cepheids are bright enough to be easily discovered, there are about as many of them as RR Lyrae stars in a given volume of space. (The apparent predominance of RR Lyrae stars is merely the result of their higher luminosity, which allows them to be observed at greater distances.) While dwarf Cepheids are thus common in the galaxy, they are almost nonexistent in globular clusters.

5. Superficially, the dwarf Cepheids fall into two groups: stars like CY Aquarii and DY Herculis with remarkably stable light curves, and stars like SX Phoenicis and Delta Scuti, whose light curves are subject to large beats.

The five short-period stars that Smith describes as dwarf Cepheids seem to form a continuous sequence, from SX Phoenicis to Delta Scuti. This sequence is plotted on the accompanying Hertzsprung-Russell diagram, together with other known or suspected sequences of pulsating stars. The short horizontal strip at absolute magnitude zero represents the true cluster-type or RR Lyrae variables. These are members of Baade's Population II, and are found in great numbers in the halo of our galaxy. On the left side of the diagram are the Beta Canis Majoris stars, which display a pronounced period-luminosity relation. This implies that the period times the square root of the mean



In this schematic Hertzsprung-Russell diagram, ordinary nonvariable dwarf stars fall along the main sequence, running diagonally across the diagram. Some known and suspected sequences of variable stars are indicated. For each individual variable plotted, the period is given in parentheses.



The variable star CY Aquarii, discovered in 1934, runs through its cycle in only 88 minutes. The light curve is from photoelectric observations by Harlan J. Smith. He also has plotted (below) the surface displacement or departure of the star's radius from its average value, during the course of a cycle. The horizontal scale is in fractions of the variable's period.

density is the same for each star, a property of any group of pulsating stars that are similar to one another in constitution.

For the dwarf Cepheids, the period-luminosity relation is even more marked than for the Beta Canis Majoris sequence. This again implies the same relation involving the period and the density, but the numerical value of the constant may be different. The periods range between 1.3 and 4.7 hours—a ratio of 3.6. Hence the range of mean densities corresponds to a factor of $(3.6)^2 = 13$. This is reasonable because Delta Scuti is a tenuous giant or subgiant star, while SX Phoenicis is a subdwarf resembling the sun in density.

The group labeled *hypothetical Maia sequence* is at present quite uncertain. Maia, a bright member of the Pleiades, has often been suspected of varying in radial velocity. W. S. Adams long ago announced it as a spectroscopic binary. More recent observations have thrown some doubt on the reality of these variations, and J. A. Pearce at Victoria is of the opinion that it is not a bona fide binary. But my own spectrographic observations with very high dispersion show that the radial velocity changes by a few kilometers per second in intervals of about an hour. The period is unknown, but may be of the order of four hours.

Another possible member of the Maia sequence is Gamma Ursae Minoris, for which I derived some years ago a period of 2½ hours from radial-velocity measurements. Several photoelectric observers have found small oscillations in the brightness of this star which also suggest a periodicity of two or three hours, but other observers have found the light to be constant. Gamma Ursae Minoris is a main-sequence *A*-type star, while Maia is an overluminous *B*8 star. (Perhaps Walker's new variable star, HD 217050, of spectral class *B*5 and with bright hydrogen lines, is also a member of this sequence. But its period of 19 hours seems rather too long, and the presence of emission lines throughout the cycle is not typical of pulsating stars.)

In the upper right-hand corner of the diagram, we have shown the beginnings of the sequences of the classical Cepheids and of the Population II, or W Virginis, Cepheids.

Sequences of Population II stars are shown by crosshatching. Their members are built upon models that differ greatly from those of Population I stars. If pulsating stars from each population were to occupy the same place in the diagram, their periods would not be the same. Hence, it need not alarm us that the RR Lyrae sequence and the dwarf Cepheid sequence intersect. (Moreover, it is not quite certain that the dwarf Cepheids really belong to Population I.)

There is, however, one serious objection to the long, almost vertical, sequence of dwarf Cepheids. It intersects the main sequence between spectral classes *A*5 and *F*0. Eggen has pointed out that the great majority of true main-sequence stars in this range do not vary in light or radial velocity. They are certainly not dwarf Cepheids. Hence he prefers to divide this sequence into two groups: one well below the main sequence, with SX Phoenicis as a typical representative, the other well above the main sequence, with Delta Scuti and DQ Cephei as examples. He is, in fact, searching for new members of this latter group.

Eggen's view is, I believe, supported by properties of the stars' motions. Those below the main sequence are drifting past the sun at an average velocity of 66 kilometers per second. While this is only two fifths of the corresponding drift for the true RR Lyrae variables, it is still too large for normal Population I stars, whose average drift referred to the sun is 20 kilometers per second. Dwarf Cepheids below the main sequence therefore look as if they were intermediate between Populations I and II. But Delta Scuti, above the main sequence, has a small radial velocity, and its spectrum is that of a Population I star.

At the present time we cannot resolve this difficulty. It may be that Eggen is correct and that there are two groups in place of one continuous sequence. Or it may be that all dwarf Cepheids are constructed differently from normal Population I main-sequence stars, in which case we would not have to worry about the intersection of a single sequence of dwarf Cepheids and the main sequence.

Amateur Astronomers

Peoria Academy of Science Observatory

IN PEORIA, Ill., an old refractor has been put back to use, an amateur astronomical society has its own telescope, and a university has observing facilities for its classes, through a co-operative enterprise stimulated by amateur astronomers.

The observatory of the Peoria Academy of Science was dedicated late in July. It houses a 9-inch f/16 refractor in a 21-foot circular concrete-block building. Still to be built is a rectangular building, 12 by 24 feet, for a meeting and warm-up room and to provide storage space. It will be attached to the present structure.

The history of the project goes back several years, when Rollin Van Zandt, chairman of the academy's astronomy section, inquired about the telescope purchased 20 years ago by Bradley University from the Illinois Watch Co., in Springfield. The 9-inch refractor with its Gaertner objective had been constructed a few years after the turn of the century. Mr. Van Zandt found that the instrument was still unmounted at Bradley, for lack of an observatory, and the astronomy section undertook to raise funds for it.

From the Peoria park board they obtained a site on the 13th tee of the Northmoor golf course, and in exchange for the site and the right to use the observatory they agreed to turn the building over to the park board.

In addition, Bradley University gave the telescope to the academy in return for permission to use the observatory for its astronomy classes. Enough money was raised for the $5,000 building and the $8,500 Astro-Dome, largely through the efforts of C. G. A. Rosen.

The telescope and mounting were rebuilt and installed by the amateurs. They also supplied the instrument with an electric drive, powered by a 1/50-horsepower motor whose rate is controlled by a precision clock built by Norman Lammers, an amateur horologist.

The observing stand to accommodate the public is rather elaborate. It consists of a 4-by-8-foot platform, which can be raised and lowered five feet by a screw-jack lift mechanism. The base of the stand rests on casters to make it easily movable.

Following its official opening, the observatory was visited by the public on Saturday nights through the summer, by an appointment arrangement worked out through the park system. Members of the astronomy section of the Peoria Academy are using the instrument for several observing programs.

FURTHER GREAT PLAINS AMATEUR CORRESPONDENCE

Interest among amateurs in the Great Plains area is now high, and we have been helped along the way by several individuals. Sparked by publication of my letter in the July issue, page 369, our membership has doubled—by July 8th we had about 85 correspondents listed.

We are now thinking seriously about having a meeting in the not-too-distant future, or possibly two meetings in the opposite ends of our area. For observing, it might prove feasible to organize some work on the opposition of Mars in 1956, or we might do some meteor study.

GEORGE EAGLETON
1422 L St.
Tekamah, Nebr.

A PURPOSEFUL QUIZ

To develop interest in her seminar in advanced astronomy at the Amateur Astronomers Association in New York City, Mary W. Schiffmann distributed a quiz containing such questions as:

How can you tell a Population I star from a Population II star?

What is the life history of a galaxy?

How does the sun get its energy, from

the carbon cycle or the proton-proton reaction?

What are the varieties of clusters, and their life cycles?

Then she added that astronomers cannot give complete answers to any of these problems, but that what they tell us points the way to some solutions. The seminar in recent advances in astronomy will study these and other questions in 1955-56, using room 1010 at the society's headquarters at 201 W. 79th St., New York City. The text will be *Stars in the Making*, by Cecilia Payne-Gaposchkin.

Mrs. Schiffmann asked each member to rate himself:

"Don't understand the questions: Serious astronomical malnutrition; you need the course in elementary astronomy [given by the AAA].

"Understand, but can't answer: Astronomical vitamin deficiency; you need to join us.

"Can answer: Your astronomical nutrition is excellent. *We* need *you*."

COLUMBUS AMATEURS

AS A RESULT of a successful campaign this spring, the Columbus Astronomical Society has boosted its membership to a new high of 125. Formed in the fall of 1946 with about eight members, the society has stimulated public interest in astronomy throughout central Ohio.

With headquarters at the McMillin Observatory on the Ohio State University campus, we have rendered assistance to the professional astronomers there, as well as at the Perkins Observatory in nearby Delaware, Ohio.

In March, 1949, a motor-driven patrol camera built by us with a war-surplus lens was presented to Perkins Observatory. It is now used for detecting asteroids and comets. After this project was completed, we dismantled and overhauled the 12½-inch McMillin telescope.

In February, 1953, at the request of Dr. J. Allen Hynek, the Columbus Astronomical Society took over management of open nights at the McMillin Observatory. We staff these guest nights on the first and third Saturdays of each month. The program includes a 20-minute illustrated lecture in the planetarium and a visit to the observatory dome, where we explain the construction and use of the telescope and, on clear nights, show celestial objects. At Perkins Observatory, on May 23rd this year, 15 of our telescopes were set up for public use on a guest night there.

HERE AND THERE WITH AMATEURS

*Members receive *Sky and Telescope* as a privilege of membership. †Member organizations of the Astronomical League.

State	City	Organization	Time	Meeting Place	Communicate With
ALABAMA	Birmingham	*Shades Valley A.C.	7:30, 3rd Tue.	Homewood Pub. Libr.	Mrs. Irvin M. Cox, 208 Dexter Ave. (9)
ARIZONA	Phoenix	*Phoenix Obs. Ass'n	8:00, 2nd, 4th Mon.	Phoenix Coll., homes	A. H. Hoff, 1102 W. Thomas Rd.
	Tucson	*Tucson A.A.	7:30, 1st Wed.	Steward Obs.	Mrs. Kathryn Burch, 216 Busch Pl.
ARKANSAS	Little Rock	†*Arkansas A.A.C.	7:30, 3rd Mon.	Various places	C. P. Kulp, 1322 Donaghey Bldg.
CALIFORNIA	Bakersfield	Bakersfield A.A.	7:30, 1st Wed.	Private homes	Gary W. Schmidt, 1700 Quincy St.
	Bakersfield	B. Stell. & Met. Ass'n	7:00, 1st, 3rd Sun.	Amer. Legion Hall	Morgan Kiker, 2711 San Emidio
	Fresno	*Central Val. Ast'mers	7:45, 2nd Mon.	Fresno Coll., homes	Elizabeth Dean, 3534 N. Callisch (3)
	Kentfield	*Marin Am. Ast.	8:00, 1st Mon.	Coll. of Marin	Rita Treleven, Box 102, Fairfax
	Long Beach	†*Excelsior Tel. Club	7:30, 3rd Fri.	Private homes	T. R. Cave, Jr., 265 Roswell Ave. (3)
	Los Angeles	L.A.A.S.	7:45, 2nd Tue.	Griffith Obs.	Miss H. Pearce, 1000 N. Seward, H'wood (38)
	Oakland	*Eastbay A.S.	8:00, 1st Sat.	Chabot Obs.	F. O. Groch, 2315 Eunice St., Berkeley (8)
	Oroville	Feather River A.C.	8:00, 2nd, 4th Tue.	Private homes	John T. Jensen, Rt. 4, Box 1732
	Palo Alto	*Peninsula A.S.	8:00, 1st Fri.	Community Center	H. W. Miner, 350 Tennyson Ave.
	Redlands	*Redlands A.S.	8:00, 4th Thu.	Univ. of Redlands	Miss R. Schweikert, 111 Prospect Dr.
	Sacramento	*Sac. Val. A.S.	8:00, 2nd Thu.	Calif. Jr. Mus.	Mrs. E. Champ, 3816 Sacramento Blvd. (17)
	San Diego	Ast. Soc. of S.D.	7:30, 1st Wed.	504 Electric Bldg.	W. T. Skilling, 3140 Sixth Ave.
	San Diego	A.T.M. Ast. Club	7:30, 2nd, 4th Mon.	3121 Hawthorn St.	Al Nelson, 3121 Hawthorn St.
	San Francisco	*S.F. Am. Ast'mers	8:00, 1st Wed.	Randall Jr. Museum	H. A. Wallace, 2925-A Jackson St.
	San Jose	*S. J. Am. Ast'mers	8:00, 3rd Mon.	State Coll., Sci. Wing	T. J. Nelson, Jr., 822 W. Iowa, Sunnyvale
	Stockton	*Stockton A.S.	8:00, 2nd Mon.	Stockton Coll., C-3	W. D. Purdy, 325 E. Kettleman Lane, Lodi
	Whittier	Whittier A.S.	7:00, Alt. Sun.	Private homes	R. N. Sturtridge, 8416 Davista Dr.
COLORADO	Boulder	*Boulder A.S.	7:30, 2nd Wed.	Sommers-Bausch Obs.	Vernon Goerke, 3045 Bluff St., HI 2-3447
	Denver	*Denver A.S.	8:00, 2nd, 4th Fri.	Chamberlin Obs.	R. A. Spencer, 1711 Washington Ave., Golden
	Pueblo	†*Pueblo A.S.	7:30, 1st Mon.	2421 2nd Ave.	Mrs. Marjorie Struthers, 2329 E. Routt Ave.
CONNECTICUT	Middletown	†*Central Conn. A.A.	8:00, 1st Tue.	Van Vleck Obs.	W. Fellows, RFD No. 1, Hill St., Glastonbury
	New Haven	†A.S. of New Haven	8:00, 4th Sat.	Sterling Tower	Florence Welter, 77 Spring Rd., N'th Haven
	So. Norwalk	†Fairfield Co. A.S.	8:00, 3rd Fri.	Stamford Museum	Goldie L. Grantham, 58 Bouton St.
DIST. COL.	Washington	†*Nat'l. Cap. Ast'mers	8:00, 1st Sat.	Comm. Dept. Audit.	Miss E. Goerner, 20 Plattsburg Ct. N.W. (16)
FLORIDA	Daytona Beach	D. B. Stargazers	8:00, Alt. Mon.	105 N. Halifax Ave.	Wm. T. Thomas, 105 N. Halifax
	Jacksonville	†*J.A.A.C.	8:30, 1st, 3rd Mon.	Private homes	E. L. Rowland, Jr., 225 W. Ashley St. (2)
	Key West	†Key West A.C.	8:00, 3rd Thu.	Private homes	J. M. Martin, 1605 United St.
	Miami	†*South'n Cross A.S.	8:15, 3rd Mon.	Central School	A. P. Smith, Jr., 426 S. W. 26 Rd.
	Miami Springs	†*Gulfstream A.A.	8:00, 4th Wed.	400 SW 2nd Ave., Miami	L. G. Pardue, 641 Falcon, 88-5434
	Orlando	*A.A.C. of Orlando	7:30, 2nd Thu.	Edgewater H.S.	Claude B. Green, 354 Mashie Lane
	Patrick AFB	†*Banana River A.S.	8:00, 2nd Wed.	PIO, Bldg. T-580	Helen DePaolo, 1353 Everglade Dr., Eau Gallie
	Pensacola	†Pensacola A.A.C.	8:00, Wed.	Private homes	John Aguilar, 1203 N. 9 Ave.
	St. Petersburg	†St. P'burg A.A.C.	7:30, 4th Tue.	City Museum Audit.	Dr. R. E. Angell, 233 5th Ave. N.
GEORGIA	Atlanta	†*Atlanta A.C.	8:00, 3rd Fri.	Agnes Scott College	W. H. Close, 225 Forkner Dr., Decatur
	Columbus	*Columbus A.A.C.	7:30, 2nd Fri.	Bradley Mem. Lib.	Mrs. J. Jones, 2605 Cherokee Ave.
HAWAII	Honolulu	Hawaii A.S.	7:30, 3rd Tue.	McKinley H.S., Cot. 36	R. Terry, 99-531 Kaholi Pl., Aiea, 463762
IDAHO	Idaho Falls	Idaho A.A.	8:00, 1st Sat.	475 J St.	Mrs. O. W. Hendrickson, 475 J St.
ILLINOIS	Chicago	†*Chicago A.S.	3:00, 2nd Sun.	Adler Planetarium	J. A. Anderer, 7929 S. Loomis Blvd. (20)
	Galesburg	†*G'burg Am. Ast'mers	7:30, 1st Wed.	Knox Obs.	L. Whitsitt, 305 W. Monmouth St., Abingdon
	Geneva	*Fox Valley A.S.	8:00, 2nd Tue.	Geneva City Hall	Joseph Zoda, 420 Fellows St., St. Charles
	Moline	†*Popular A.C.	7:30, Wed.	Sky Ridge Obs.	Carl H. Gamble, 3301 Coaltown Rd.
	Peoria	Ast. Sec., Acad. Sci.	8:00, 1st Wed.	Glen Oak Pk. Pav'n.	R. P. Van Zandt, 156 N. Eleanor Pl. (5)
INDIANA	Indianapolis	†*Indiana A.S.	2:15, 1st Sun.	Riley Library	W. E. Wilkins, 6124 Dewey Ave. (19), IR-5946
	South Bend	*St. Jos. Valley Ast.	7:30, 1st Thu.	YMCA	Bruce A. Lovell, RR 6, Box 61A
KANSAS	Wichita	†*Wichita A.S.	8:00, 1st Wed.	Friends Univ.	S. S. Whitehead, 425 N. Lorraine (8), 62-6642
KENTUCKY	Louisville	†L'ville A.S.	8:00, 1st Tue.	Univ. of Louisville	B. F. Kubaugh, 207 Sage Rd. (7)
	Louisville	†*L'ville Jr. A.S.	7:30, 3rd Tue.	Private homes	Carol Lipphard, 2421 Calvin Ave. (6)
LOUISIANA	Gretna	Gretna A.S.	7:00, 2nd, 4th Sat.	209 Newton St.	John A. Gunther, 209 Newton St., Algiers 2710
	Lake Charles	†*Lake Charles A.A.C.	7:45, 2nd Tue.	H.S. Chem. Lab.	Norman G. Lore, 532 Alamo St.
	New Orleans	A.S. of N.O.	Irregular	Cunningham Obs.	Dr. J. Adair Lyon, 1210 Broadway
MASSACHUSETTS	Cambridge	†*Bond A.C.	8:00, 1st Thu.	Harvard Obs.	R. Smith, 519 Quincy Shore Dr., No. Quincy 71
	Cambridge	†*A.T.M.s of Boston	8:00, 2nd Thu.	Harvard Obs.	W. Knight, 75 S. Crescent Cir., Brighton 35
	Springfield	†*S'field Stars	8:00, 2nd Wed.	Private homes	J. Welch, 107 Low'r B'verly Hills, W. S'field
	Worcester	†*Aldrich A.S.	7:30, 1st, 3rd Tue.	Mus. Natural Hist.	W. C. Lovell, 24 Courtland (2), 3-1559
MICHIGAN	Battle Creek	†B. C. A.A.C.	8:00, 2nd Fri.	Kingman Museum	Mrs. W. V. Eichenlaub, 47 Everett Ave.
	Detroit	†*Detroit A.S.	2:30, 2nd Sun.	Wayne U., State Hall	E. R. Phelps, Wayne University
	Jackson	*Jackson A.S.	7:30, 2nd Thu.	Public Library	Allen Bell, 1103 Hamlin Pl.
	Kalamazoo	†Kalamazoo A.A.A.	8:00, Sat.	Private homes	Edgar Pashby, 420 Evelyn Ave.
	Lansing	†*Lansing A.A.	8:00, Sat.	Private homes	R. Elliott, 434 Cowley Ave., E. Lansing
	Pontiac	†*Pon.-N.W. Det. A.A.	7:30, 3rd Thu.	Lincoln Jr. H.S.	G. Carhart, 40 Hadsell Dr., FE 2-9980
MINNESOTA	Minneapolis	*J.A.C. of M'polis	4:15, 2nd, 4th Wed.	Public Library	E. Haskins, 3732 Garfield Ave. S., RE-0201
	Minneapolis	M'polis A.C.	7:30, 1st Wed.	Public Library	Maxine Begin, Sci. Mus., M'polis Pub. Lib.
	St. Paul	†*St. Paul Tel. Club	7:30, 2nd, 4th Wed.	Macalester Coll.	John Fleischhacker, 3520 Edgerton St. (6)
MISSOURI	Fayette	†*Central Mo. A.A.	7:30, 3rd Sat.	Morrison Obs.	R. C. Maag, 816½ S. Mass., Sedalia
	Kansas City	†*A.C. of Kans. City	8:00, 4th Sat.	K.C. Museum	Mrs. Laura Kinsey, 4604 Jefferson (12)
	St. Louis	†*St. Louis A.A.S.	8:00, 3rd Fri.	Inst. of Tech., St. L. U.	Mrs. N. Fallert, 1509 N. Berry Rd., Rock Hill (19)

The society has carried on an education program for schools in Columbus and vicinity. At the request of school officials, members take their instruments to school grounds for observing sessions and discussions with students. We have 75 telescopes, about 65 of them made since the first telescope committee was named in 1949.

Our monthly lecture meetings are open to the public. For members we hold regular discussion groups, in basic, intermediate, and advanced astronomy. Our publication, *Prime Focus*, is distributed each month, and our membership privileges include *Sky and Telescope*.

Amateurs in Columbus at any time are invited to take part in our program.

M. JANE GANN
420 N. Cassady Rd.
Columbus 9, Ohio

THIS MONTH'S MEETINGS

Kalamazoo, Mich.: Kalamazoo Amateur Astronomical Association, 8 p.m., home of Dr. and Mrs. L. N. Upjohn, 1556 Long Rd. Sept. 17, Spencer Van Valkenburgh, "Some Fundamentals of Astronomy."

Long Beach, Calif.: Excelsior Telescope Club, 8 p.m., home of John C. Dayton, 4409 Graywood Ave. Sept. 23, Frank Daley, "Barlow Lenses."

DENVER CONFERENCE

The Denver Astronomical Society is planning an amateur astronomers' conference to be held on the campus of the University of Denver, in Colorado, from Friday, September 9th, to Sunday, the 11th.

Cosponsored by the university, the conference will be an informal get-together of all interested persons in the Rocky Mountain area, either as individuals or as members of a society.

One purpose of the meeting will be to discuss possible formation of an area association of amateur astronomers that could assist member societies, and would be of particular service to the isolated individual currently forced to work completely on his own because of the great distances separating communities in this sparsely populated area.

All interested astronomers, amateur or professional, are invited to write for program information and details of reservation and registration procedure.

WILLIAM R. VAN NATTAN
1180 Rosemary St.
Denver 8, Colo.

HERE AND THERE WITH AMATEURS *(continued)*

State	City	Organization	Time	Meeting Place	Communicate With
NEVADA	Reno	A.S. of Nev.	8:00, 4th Thu.	Univ. of Nevada	Dr. Vernon Frazier, University of Nevada
NEW HAMPSHIRE	Newmarket	*Gr't Bay Am. Ast'mers	7:30, Alt. Tue.	Public Library	A. R. Brackett, 72 Gov't. St., Kittery, Me.
NEW JERSEY	Caldwell	West Essex A.S.	8:30, 2nd Mon.	Caldwell Mun. Bldg.	Donald C. Smith, 19 Francisco Ave.
	Cranford	†*A.A.S. of Union Co.	8:00, 4th Fri.	Plainfield YWCA	Mrs. W. N. Lurcott, 220 High St.
	Rutherford	A.S. of Rutherford	8:00, 1st Thu.	YMCA	Mrs. Helen Waite, 11 Bryan Ct.
	Teaneck	†Bergen Co. A.S.	8:30, 2nd Wed.	Obs., H.S. grounds	C. Milos, 631 Ridgewood Rd., Oradell
NEW MEXICO	Las Cruces	†*A.S. of L.C.	7:30, 1st or 2nd Sat.	Private homes	W. H. Haas, 1203 N. Alameda Blvd.
	Roswell	*Pecos Val. S.&T.C.	7:30, 2nd Fri.	Cham. of Comm.	Dr. R. R. Boice, Rt. 2, Box 163A
NEW YORK	Brooklyn	†Junior A.C.	8:00, 3rd Fri.	B'klyn Public Library	Jr. A. C., Pub. Lib., Grand Army Plaza (38)
	Buffalo	†*Buffalo A.A.	7:30, 1st Wed.	Mus. of Science	W. Semerau, 135 Zimmerman Blvd. (17)
	Corning	Corning A.C.	8:00, 1st, 3rd Mon.	Corning Glass Center	W. R. Redmond, 3 E. 3rd St.
	Gloversville	†A.C. of Fulton Co.	6:30, Wed.	Private homes	Emmanuel Weil, 38 E. Blvd.
	New York	*A.A.A.	8:00, 1st Wed.	Amer. Mus. Nat. Hist.	G. V. Plachy, 201 W. 79th (24), EN 2-7100
	Rochester	†Ast. Sec., Acad. Sci.	8:00, 1st Fri.	Rochester Museum	Margaret Frisch, 38 Harris St. (21)
	Schenectady	†*S'tady A.C.	7:30, 3rd Mon.	Union Coll., C.E. Bldg.	C. E. Johnson, 102 State St.
	Syracuse	†*Syracuse A.S.	8:00, 4th Thu.	Syr. U., 206 Steele	Dr. G. J. Mittelman, 110 Gray Ave. (6)
	Troy	†*Renss. Ap. Soc.	8:00, Fri.	R.P.I. Obs.	Dr. Robert Fleischer, R.P.I.
	Troy	†*Troy A.C.	8:00, 4th Sat.	Private homes	P. Cenni, 2316 6th Ave.
	Utica	†*Utica Am. Ast'mers	7:30, 4th Tue.	Proctor Inst.	S. Wolczanski, 506 William St.
	Wantagh	Long Island A.S.	8:00, Sat.	Private homes	A. R. Luechinger, 2009 Seaford Ave., 1571
N. CAROLINA	Chapel Hill	†Chapel Hill A.C.	8:00, Alt. Wed.	Morehead Plan.	C. C. Tucker, Jr., Morehead Planetarium
	Charlotte	*Charlotte A.A.C.	8:00, Last Mon.	Myers Pk. H.S.	Mrs. L. W. Kelly, 1014 Kennilworth Ave. (3)
	Greensboro	†*Greensboro A.C.	8:00, Fri.	Woman's Coll., U.N.C.	Dr. A. D. Shaftesbury, 315 Tate St.
	Winston-Salem	†*Forsyth A.S.	7:30, Last Fri.	Private homes	Kenneth Shepherd, 903 W. End Blvd.
NORTH DAKOTA	Grand Forks	†*Red River A.C.	8:00, 2nd, 4th Mon.	City Hall	L. G. Peck, 2101 1st Ave. North
OHIO	Akron	*A.C. of Akron	8:00, Last Fri.	YMCA	Mrs. R. J. Couts, 878 Kennebec Ave. (5)
	Cincinnati	*Cin. A.A.	8:00, Various days	Cincinnati Obs.	James T. Mettey, 2914 Minot Ave. (9)
	Cincinnati	*Cin. A.S.	8:00, 3rd Fri.	Obs., Zion Rd., M. Hts.	Isolina Cartlidge, 5556 Raceview Ave. (11)
	Cleveland	Cleveland A.S.	8:00, Fri.	Warner & Swasey Obs.	Mrs. Helen Strohm, Warner & Swasey Obs.
	Columbus	*Columbus A.S.	8:00, 2nd Sat.	McMillin Obs.	Miss R. A. Charlton, 1361 E. 22 Ave. (11)
	Dayton	A.T.M.s of Dayton	Eve., 3rd Sat.	Private homes	F. E. Sutter, 5038 Lebanon Pike (9)
	Lorain-Elyria	*Black River A.S.	8:00, 1st Wed.	Ely School	Leonard Sipple, Box 231
	Marietta	Marietta A.S.	Irregular	Cisler Terrace	Miss L. E. Cisler, Cisler Terrace
	Toledo	Toledo Ast. Club	...., 3rd Tue.	Univ. of Toledo Obs.	E. D. Edenburn, 4124 Commonwealth Ave.
	Warren	Mahoning Val. A.S.	8:00, Fri.	Private homes	C. R. Prather, 1363 Drexel, NW, 4494-2
	Youngstown	*Y'town A.C.	7:30, 1st Fri.	Homestead Pk. Pav'n.	F. W. Hartenstein, 907 Brentwood
OKLAHOMA	Tulsa	†*Tulsa A.S.	7:30, 1st Sat.	Private homes	J. C. Wells, 524 S. 78th E. Ave.
OREGON	Portland	†*Portland A.S.	7:30, 1st Tue.	Central Public Lib.	Mrs. Marge Krutsinger, 6525 NE Davis St. (16)
	Portland	†A.T.M. & Observers	8:00, 2nd Tue.	Private homes	Mrs. Marge Krutsinger, 6525 NE Davis St. (16)
PENNSYLVANIA	Beaver	†*Beaver Co. A.A.A.	8:00, 2nd Tue.	Private homes	Mrs. R. T. LuCaric, Brownsdale Plan, Baden
	Harrisburg	†A.S. of Harrisburg	8:00, 1st Mon.	State Museum	Edward J. Naylor, 320 Wilhelm Rd.
	Millvale	A.A.A. Shaler T'ship	8:00, 1st Fri.	Cherry City Fire House	Cliff Raible, 200 Rebecca Sq. (9)
	Philadelphia	†A.A. of F.I.	8:00, 3rd Fri.	Franklin Institute	Edwin F. Bailey, LO 4-3600
	Philadelphia	†*Rittenhouse A.S.	8:00, Fri.	Franklin Institute	John W. Streeter, LO 4-3600
	Pittsburgh	†*A.A.A. of P'burgh	8:00, 2nd Fri.	Buhl Planetarium	Mary Burcik, 315 Moore Ave. (10)
	Pottstown	†Pottstown A.A.C.	7:30, Fri.	Public Library	W. E. Schultz, Public Library
	Springdale	*Allegheny Val. A.A.A.	8:00, 1st, 3rd Fri.	Private homes	Wm. E. Stocks, 215 Carson St.
RHODE ISLAND	N. Scituate	Skyscrapers, Inc.	8:00, Mon. or Wed.	Seagrave Mem. Obs.	Seagrave Mem. Obs., Box 157
TENNESSEE	Chattanooga	†*Barnard A.S.	8:00, 3rd Fri.	Jones Observatory	A. H. Jones, 411 W. 21st St., 5-1646
	Memphis	†Memphis A.S.	7:30, 1st, 3rd Fri.	Private homes	J. M. Buhler, 3796 Central Ave.
	Nashville	*Barnard A.S.	8:00, 2nd Thu.	Dyer Observatory	Miss C. Kidd, Dyer Obs., Vanderbilt U.
TEXAS	Abilene	*Abilene A.S.	7:30, 4th Mon.	Phys. Rm., H.-S.U.	T. D. Roberts, Hardin-Simmons Univ.
	Austin	†*Forty Acres A.C.	7:30, 1st Tue.	U. of Tex., Physics Bldg.	Forty Acres A.C., Box 7994, Univ. Sta.
	Brownfield	*Brownfield A.C.	8:00, 3rd Wed.	Private homes	Charles W. Isbell, Brownfield 2074
	Dallas	†Texas A.S.	8:00, 4th Mon.	Various auditoriums	E. M. Brewer, 5218 Morningside, UN-3894
	Ft. Worth	†*Ft. Worth A.S.	8:00, 4th Thu.	Children's Museum	James M. McMillen, 604 Tierney Rd. (3)
	Laredo	*Laredo A.C.	8:00, 2nd Tue.	Laredo Jr. Coll.	Sidney Freidin, Box 1148
	Port Arthur	†*Port Arthur A.C.	7:30, 2nd Thu.	5228 Fifth St.	F. T. Newton, 5213 Fifth St., 2-4807
UTAH	Salt Lake City	*A.S. of Utah	8:00, 2nd Fri.	City and County Bldg.	James W. Geertsen, 4461 S. 9th East St.
VIRGINIA	Harrisonburg	Astral Society	Monthly	Vesper Heights Obs.	M. T. Brackbill, Eastern Mennonite College
	Norfolk	†*Norfolk A.S.	8:00, 2nd Thu.	Museum of Arts	A. Hustead, U.S. Weather Bureau, LO 3-4368
	Richmond	†*Richmond A.S.	8:00, 1st Tue.	601 E. Franklin St.	B. S. Ragland, 601 E. Franklin St. (19)
	Roanoke	*Am. Ast'mers of Roa.	...., 2nd Fri.	YMCA	Mrs. K. Burke, 11 Mountain Ave. SE 3-2359
WASHINGTON	Seattle	†*Seattle A.A.S.	8:00, 2nd Wed.	Eagle'n Hall, 1417 E. 42	Norman Dalke, 3640 Densmore Ave.
	Spokane	†*A.T.M.s of Spokane	8:00, Last Fri.	Private homes	Sue Stockton, S. 2129 Grand Blvd.
	Tacoma	†Tacoma A.A.	8:00, 1st Mon.	Coll. of Puget Sd.	Mrs. Roy Atkinson, 2816 N. Union Ave.
	Yakima	†*Yak. Am. Ast'mers	8:00, 2nd Mon.	Cascade Creamery	Edward J. Newman, 324 W. Yakima Ave.
WEST VIRGINIA	Fairmont	†Fairmont A.A.A.	7:30, 2nd Fri.	State Coll., Sci. Hall	David Meisel, 800 8th St.
WISCONSIN	Beloit	†*Beloit A.S.	7:30, 2nd, 4th Wed.	YMCA Bldg.	K. E. Patterson, 318 Public Service Bldg.
	Madison	†Madison A.S.	8:00, 2nd Wed.	Washburn Obs.	Dr. C. M. Huffer, Washburn Obs.
	Milwaukee	†*Milw. A.S.	7:45, 3rd Fri.	Finney Branch Lib.	E. A. Halbach, 2971 S. 52 St. (15)
	Sheboygan	*Sheboygan A.S.	7:30, 2nd Tue.	Mead Public Lib.	T. Kruschke, 2016 N. 8th St.

ECLIPSE IN CEYLON

(Continued from page 455)

served the effect of the eclipse on animal life. Fruit bats came out during totality. Elephants, normally docile and anxious to avoid humans by day, left their night abodes and passed near the observing site. Dogs were unaffected.

Ceylon is populated by varied ethnic and religious groups who are extremely proud of their heritage of a highly advanced civilization in the early centuries of our era, intensely loyal to their leaders' teachings, and keenly aware of their newly acquired independence. Among such people, many differing reactions to the physical occurrence of the eclipse were to be expected.

For several months before the eclipse articles of all kinds appeared in the local newspapers. Some were factual, describing the path of totality and explaining the sun-moon-earth relationship. Others reported weather analyses and recounted the plans and actions of the observing teams. Some explored ancient records of eclipses. Many people became convinced that the eclipse portended evil and misfortune for Ceylon, and especially for the visiting astronomers. It was widely reported that those who viewed the eclipse would suffer eye injury or loss of sight. One *ayurvedic* doctor prescribed a potion to be consumed during totality. Unfortunately, the concoction was toxic and resulted in "eclipse sickness" for those who drank it. In one locality 200 people reported to the government hospital, of whom 90 required bed treatment.

The department of health issued statements in all three island languages (English, Singhalese, and Tamil) warning observers to take great care in looking at the sun, and advising that the eclipse viewers sold in great numbers were not dependably safe. In Batticaloa, we held many conferences with the local residents, including the chairman of the urban council, who was, incidentally, an ayurvedic physician. Apparently impressed by the matter-of-fact attitude of the visitors, and led by the chairman who observed with the Americans, hundreds gathered at the site of the Hayden Planetarium photographic equipment.

Just before their departure, the leaders of the American teams attended a luncheon with Ceylon's prime minister, Sir John Kotelawala. He displayed a picture of totality taken at Kalkudah. The occasion was a fitting climax to an experience we shall long remember.

FUTURE LONG ECLIPSES

The unusually long duration of totality at the June 20, 1955, total eclipse of the sun naturally raises the question of when such a duration may be expected again. Dr. C. H. Smiley and Mary Quirk, in the *Journal* of the Royal Astronomical Society of Canada, report their calculations for some other long eclipses. The following durations are given as probably within three per cent of the true values:

1973	June 30	7 min.	06 sec.
2132	June 13	6	57
2150	June 25	7	13
2168	July 5	7	24
2186	July 16	7	29
2204	July 26	7	23

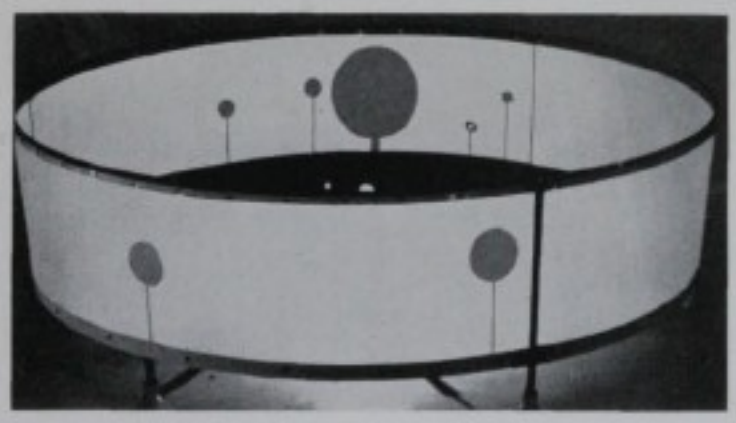
On the basis of these calculations, it would appear that the next eclipse whose duration of totality will exceed this year's will be that of June 25, 2150, and not the 2168 eclipse as stated on page 142 of the February issue.

METEORITICAL SOCIETY

The 18th meeting of the Meteoritical Society will be held on September 12-13 at the Institute of Meteoritics of the University of New Mexico, Albuquerque. All scientific sessions will be open to the public. Dr. Lincoln LaPaz, director of the institute, is chairman of the program committee.

NEW ASSISTANT DIRECTOR

Dr. J. S. Rinehart became assistant director of the Smithsonian Astrophysical Observatory, Cambridge, Mass., late in July. Dr. Rinehart has been associated with the National Bureau of Standards and with the Naval Ordnance Test Station, China Lake, Calif. His scientific work has included extensive research on the mechanical properties of metals.



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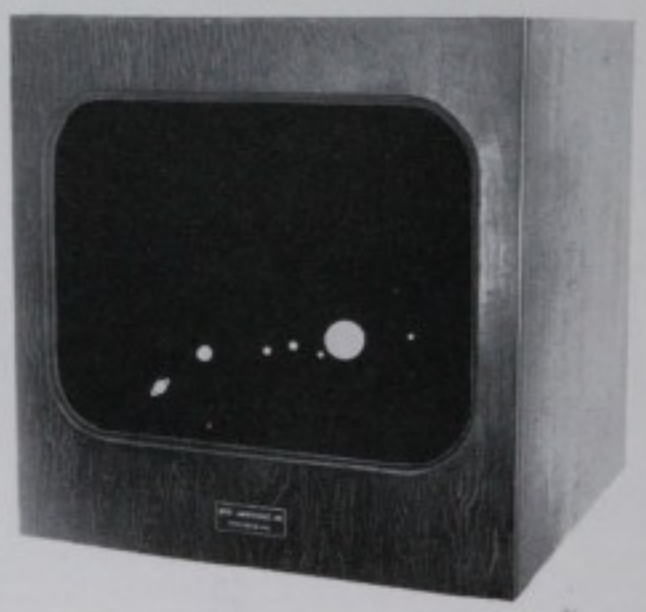

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BOOKS AND THE SKY

THE CRIME OF GALILEO

Giorgio de Santillana. University of Chicago Press, Chicago, 1955. 339 pages. $5.75.

THE STORY of the trial of Galileo is one of the most famous chapters in the history of science. Superficially, the record as known to most of us is fairly straightforward. Galileo was a new and original thinker; his support of the Copernican system with both observations and theory met with the displeasure of a conservative church, tied to the Aristotelian point of view, and he was forced to recant by the Inquisition.

Professor de Santillana, who has recently translated Galileo's *Dialogue on the Great World Systems,* has taken a long and careful look at the famous meeting of Galileo and the Church. He points out that the story of events, as he found it, really makes very little sense. In fact, it is hard to see how Galileo, who was a devoutly religious man, who had broken none of the Church's conventions, who had even gotten the papal imprimatur on his *Dialogues,* could have come to such grief. And from here on *The Crime of Galileo* reads like a mystery story. What, indeed, was Galileo's crime?

Here lies the remarkable analogy that the author is quick to point out between the case of Galileo and, three centuries later, the Oppenheimer security hearings. Prof. de Santillana writes: "One might say for instance: for 'Holy Office' read 'AEC Board,' for 'Caccini' read 'Crouch,' for 'Lorini' read 'Borden' . . . for 'Report of the Preliminary Commission' read 'Gray-Morgan Majority Report,' for 'Grienberger' read 'Teller' . . . ." And over and above the simple enumeration of one-to-one correspondence, we see the most important parallel. Just as it is difficult for the modern historian to determine the exact crime of Galileo, so will it be extraordinarily difficult for the historian of the 21st century to ascertain what was the "crime" of Oppenheimer.

In trying to make sense out of the story of Galileo, the author takes the reader into a marvelous maze. The trail leads through the great clerical hierarchy, many of whose members were actually followers and supporters of Galileo, through the Jesuit and Dominican orders, whose countermaneuvers for power form a vise in which Galileo seems to have been unwittingly caught. The original examination of Galileo by Cardinal Bellarmine is a prelude to the final drama, but meanwhile gives rise to the famous injunction which Galileo was supposed to have violated. The author sets forth clear arguments that there was no legal basis for action against the astronomer. One even begins to wonder if the movers behind the scenes were really against Galileo or Copernicanism. Who the real movers are is never clear.

Galileo was also hated by the scholarly hierarchy of his time. There were Romans who were prejudiced against the Florentine. And, finally, there were some who really thought that he was a heretic. Galileo was simply too able, and therefore had too many enemies. "His was the tragedy of an excess of gifts; for, while the telescope was his key to success, his real social strength lay in his extraordinary literary capacity, his brilliant repartee, his eloquence and charm."

The crux of Galileo's case, along with its modern parallels, is seen to lie in the regimentation of thought. For as soon as men's thoughts and beliefs become the business of an instrument of government, be it a church-state or a personnel security board, then the means exist for the suppression of original thought, even though the thinker may follow the rules laid down by authority.

It can be readily seen that this is a very interesting book, and the author manages to relate a great amount of historical detail in a coherent and readable way. About the only criticism that might be set forth is in the mechanical question of the footnotes. These are quite long, often running for several pages, and invariably interesting; thus the reader finds himself following two simultaneous stories at once. Perhaps more of the footnotes could have been incorporated in the text.

HAROLD ZIRIN
Harvard College Observatory

ROCKET EXPLORATION OF THE UPPER ATMOSPHERE

R. L. F. Boyd and **M. J. Seaton,** editors. Interscience Publishers, Inc., New York, 1954. 376 pages. $11.00.

THE ROCKET as a scientific "weapon" came into extensive use in 1946 when it was announced that 100 captured V-2 rockets would be launched by the U. S. Army. Invitations to instrument the rockets for high-altitude studies were extended to service agencies of the government and to universities. Between March 15, 1946, and October 29, 1951, 63 V-2 rockets had been launched at White Sands, N. M., of which 44 attained altitudes of 50 to 132 miles above the surface of the earth.

Concurrent with the program of V-2 flights, a family of rockets of American design and manufacture was developed, including the Viking, Aerobee, WAC Corporal, and Deacon. By January of 1951 there had been nine launchings of the Viking (maximum altitude 136 miles) and 81 of the smaller Aerobees (maxi-

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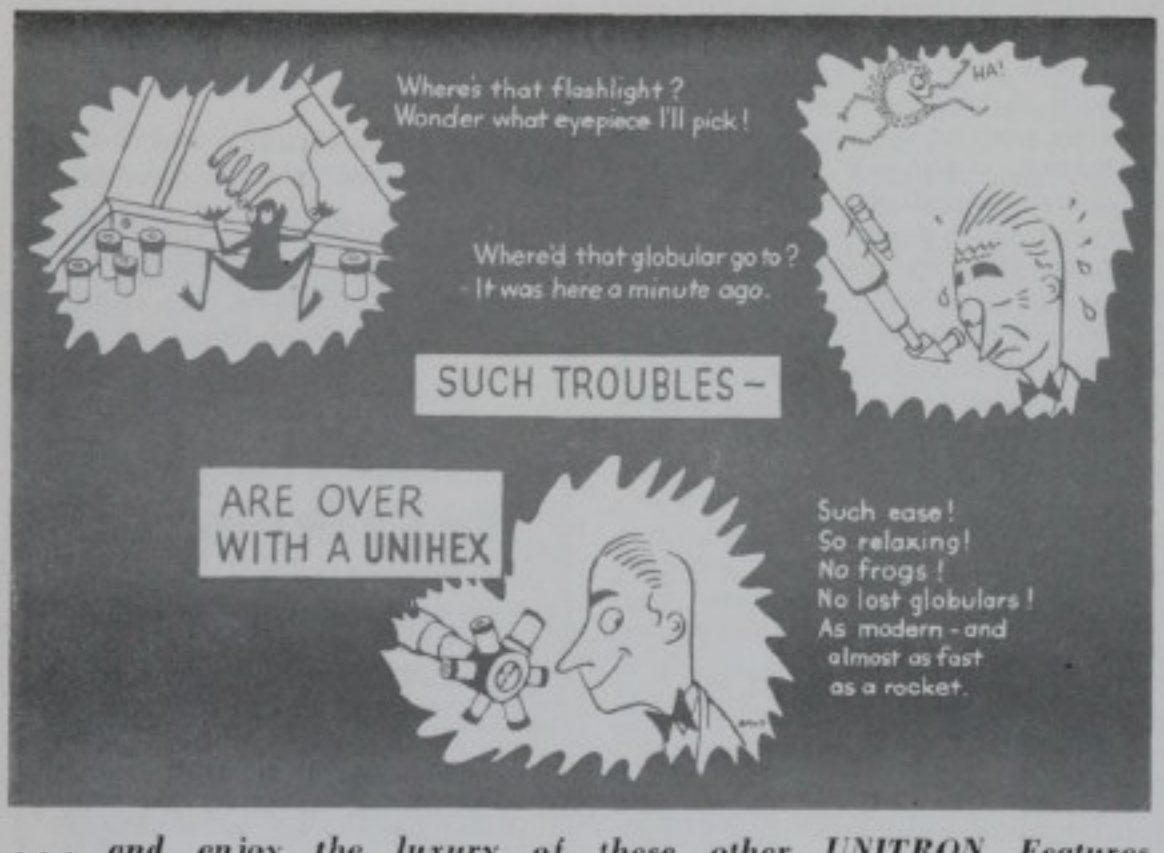

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mum altitude 80 miles). To complete the compilation, mention should be made of the Rockoon, a Deacon rocket launched from a balloon (maximum altitude 65 miles), and the Bumper, a WAC Corporal launched from a V-2 (the record altitude of 242 miles).

By 1953 a large amount of data on the upper atmosphere had been collected, and an international conference for the discussion of the results was held in Oxford on August 24-26, 1953, sponsored jointly by the Upper Atmosphere Rocket Research Panel of the United States and the Gassiot committee of the Royal Society of London. The papers presented at the conference, 49 in all, constitute the book under review, published as a special supplement to the *Journal of Atmospheric and Terrestrial Physics*.

The book is predominantly on the research level and thus of particular value to active workers in either rocketry or upper-atmosphere physics. The general reader will, however, find much of interest, and will be able to read between the lines something of the drama and frustration of rocketry, as its primary emphasis evolved from engineering problems to instrumentation for investigations of the properties of the upper atmosphere. (See also the August, 1954, *Sky and Telescope* for a review of a book by Homer E. Newell, Jr., *High-Altitude Rocket Research*.)

The major divisions of the book deal with rocket techniques; pressures, temperatures, and winds; composition of the high atmosphere; the ionosphere, solar radiation, and geomagnetic variations; rocket cosmic ray measurements; laboratory studies; and theoretical considerations and suggested experiments.

Perhaps the most definitive results up to the time of the printing of the book are those on pressures, densities, and temperatures. From measurements of ambient and nose pressures during flight it is possible to deduce densities and temperatures for various layers of the atmosphere. The reader interested in actual numerical values for these quantities will profit by the compilation recently made by the Rocket Panel (*Physical Review, 88*, 1027, 1952). Direct measurements from rocket flights have now been extended to 220 kilometers (137 miles). For the first 120 kilometers above the earth's surface the measurements are quite numerous. In general, the results confirm previous indirect estimates. The temperature is found to have a minimum near 20 kilometers, a maximum near 50, and a second minimum near 80. Above 120 kilometers there have been only two measurements, one at 160 and another at 220 kilometers, up to which level there appears to be a steady increase in temperature.

Considerable effort has been expended to attempt a measurement of the chemical composition of the upper atmosphere, both by the obtaining of air samples and by mass spectrometric methods. No positive evidence is reported for any diffusive separation of the lighter and heavier components of the atmosphere up to a height of 100 kilometers. A maximum of ozone concentration at 20 kilometers has long been predicted on the basis of spectrophotometric methods (the so-called Umkehr effect). Balloon measurements, and more recently rocket observations, have confirmed this maximum.

That ionized regions exist in the upper air has been known for some decades, based on experiments on the reflection of radio waves from that portion of the atmosphere usually called the ionosphere. Most of the rocket experiments for the measurement of the atmosphere's ionic properties have been based on radio propagation techniques, involving radio communication between the rocket and the ground. The interpretation of such data is complicated, and the method is not essentially more direct than that in which both the transmitter and the receiver are on the ground. Some preliminary work is reported in this book on the use of a Langmuir probe technique for the direct measurement of ion density during rocket flights.

Of particular interest to astronomers is a paper by William Liller and Fred L. Whipple on meteor-train photography, which gives evidence of high-velocity winds and shears in the 80-to-110-kilometer region of the atmosphere. Other

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125—Jupiter, Saturn, Mars (100-inch), and Pluto (200-inch)
126—Head of Halley's Comet, May 8, 1910 (60-inch reflector)
127—Halley's Comet (14 views) April 26 to June 11, 1910
128—Comet Cunningham (5-inch Ross lens) Dec. 21, 1940
129—Constellation Orion (Tessar lens, 10" focal length)
130—Orion, Great Nebula in red light (18-inch Schmidt)
131—Nebulosity, Orion, IC 434, Great Nebula bottom right
132—North America Nebula, Cygnus, south
133—Filamentary Nebula, Cygnus, whole loop (18-inch Schmidt)
134—NGC 6960, Filamentary Nebula, Cygnus (100-inch)
135—NGC 6960, Filamentary Nebula, north
136—NGC 6960, Filamentary Nebula, south
137—Spiral Nebula, Pegasus, NGC 7331 (200-inch)
138—Spiral Nebula, Pegasus, NGC 7217 (200-inch)
139—Pleiades, nebulosity around Merope in red (18-inch Schmidt)
140—Pelican Nebula, Cygnus (100-inch)
141—Great Nebula, NGC 224 Andromeda, plus NGC 205 and 221 (48-inch Schmidt)
142—Andromeda Nebula, central part, NGC 224 (100-inch)
143—Galactic Nebula, Monoceros, NGC 2237, in red (48-inch Schmidt)
144—Enlarged section of above, Monoceros, NGC 2237

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Rocket studies of the upper atmosphere are continuing, and during the International Geophysical Year (1957-58) it is planned to launch about 150 rockets for scientific purposes, including a dozen launchings of the French Veronique in Algeria. The decennial of the 1953 Oxford meeting would seem to be an appropriate time for another conference, to which space-travel enthusiasts should be invited. As mentioned in one of the papers in the book under review: "Space travel will come sooner by making today's rockets fly higher and farther."

FRANKLIN E. ROACH
Boulder Laboratories
National Bureau of Standards

INTRODUCTION TO ASTRONOMY

Cecilia Payne-Gaposchkin. Prentice-Hall, Inc., New York, 1954. 508 pages. $8.00.

"STAR differs from star in glory" might well be the motto of modern astronomy, so that we often feel a need for an elementary text that thinks of "the stars as individuals," and this is precisely what Dr. Cecilia Payne-Gaposchkin, of Harvard Observatory, has given us in *Introduction to Astronomy*.

The last few decades have added greatly to our knowledge of stars, by advances in photographic techniques, by the appreciation of the extent of the interstellar medium, and by the application of the new nuclear physics. This amounts to such a revolution that older books are no longer useful. I own a 1903 *Lessons in Astronomy*, by C. A. Young. For the astronomy of the solar system, Mrs. Gaposchkin's chapters on "The Sun" and the "Evolution of the Solar System," as well as many shorter sections, would have astonished and delighted Professor Young, while the sections on stellar astronomy have very little material in common with his. He did justice to his knowledge of the stars in a quarter of his book; it takes Mrs. Gaposchkin very nearly a half of hers.

Readers of Otto Struve's articles in *Sky and Telescope* know of this change in emphasis and the widening of the area of our knowledge. But by its nature a periodical gives a piecemeal picture of any field, and must be supplemented by a book giving a comprehensive survey. The book, in its turn, may suffer from being outdated in places before publication.

Even so, the amateur will find *Introduction to Astronomy* an excellently readable and authoritative book, with fine, if sometimes somewhat small, diagrams. The tables are numerous and fascinating. It is true that it would be more convenient to use them for reference if they were all together, but that would reduce the volume's efficiency as a textbook. Possibly an index to the tables might be practicable.

Groups of amateurs wishing to study together may well consider the use of this as their text. People sufficiently adult and sufficiently interested to learn out of curiosity should find it well adapted to the seminar method of study, and astronomy is one subject where a teacher who knows all the answers, while very helpful, is not essential.

Such groups would do well to bear in mind that in condensing planetary astronomy to make room for the stars, certain topics have had to be drastically curtailed. For instance, terrestrial magnetism is treated in eight lines. It might have been better to have omitted it altogether rather than say so little, but this is a matter of opinion. If this condensation causes confusion, it may be necessary to check with another text occasionally.

The paper, printing, and binding are good. It would be a help to have a listing of the Greek alphabet in an appendix, if only because the style of characters in the book is just sufficiently unusual to be confusing.

The proofreading could also have been improved. One slip I noticed is on page 269, where the heading of the sixth column in the table should read "Radius" instead of "Mass," as a comparison with the table on page 283 will show.

It is hoped that such a useful book will find its way into the libraries of many amateur astronomers and will require many editions.

MARY W. SCHIFFMANN
Amateur Astronomers Association
New York City

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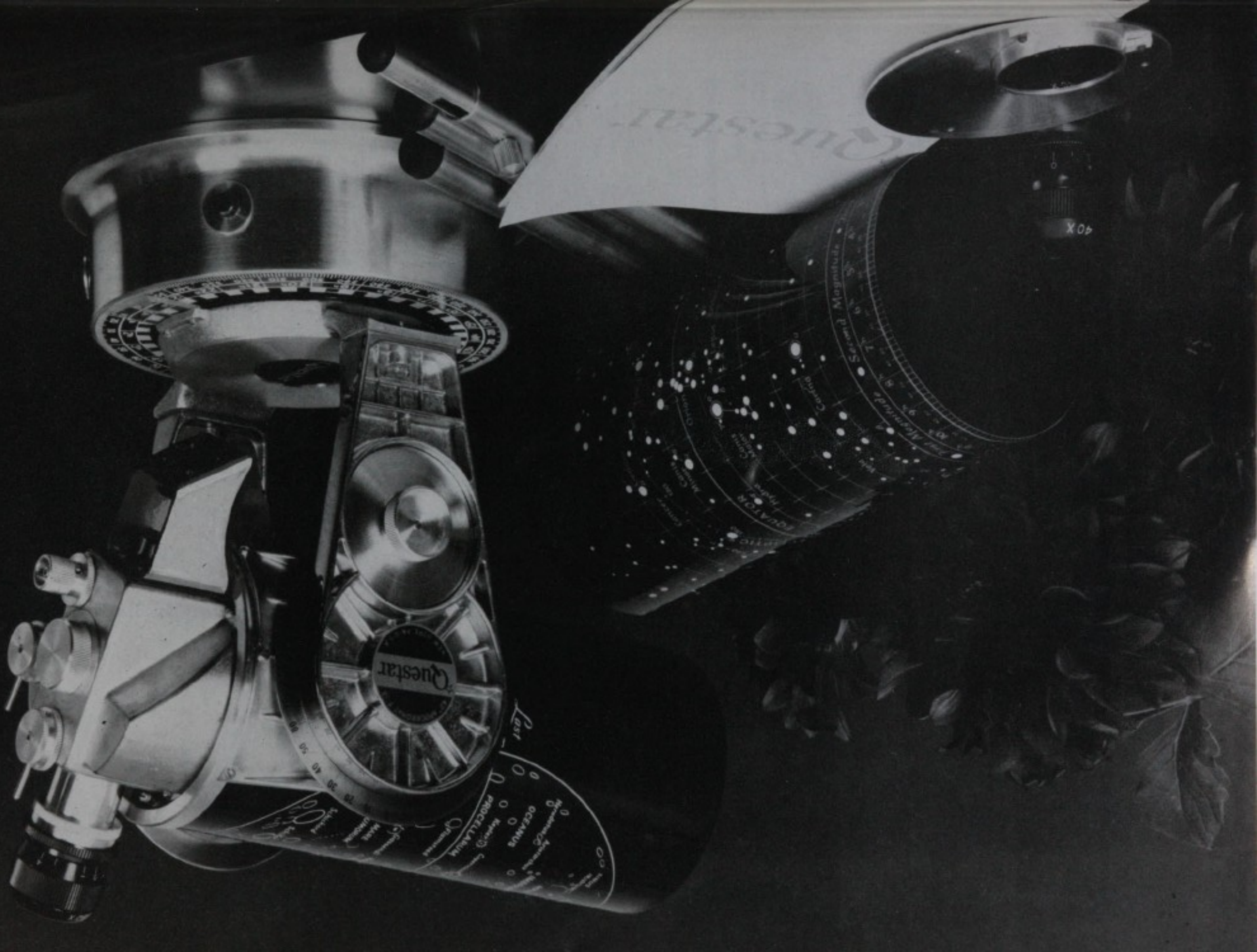
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EDITED BY EARLE B. BROWN

Notes on Basic Optics—XV

O. Chromatic Aberration—continued

3. **Color Curve of a Lens.** Our July installment explained the design of an achromatic lens—the combination of a positive and a negative lens, which together will have the same focal length for light of two chosen colors. But what of light of other wave lengths? If, for a typical achromatic doublet, we plot equivalent focal length against wave length, we obtain a curve like that in Fig. 49, which tells us several interesting things.

First, we note that various colors of light come to a focus in pairs. The particular achromatic lens to which the curve refers was designed to bring light of wave lengths C and F to a single focus; other pairs of colors are brought together at focal lengths different from the C-F focus. Second, there is a minimum focal length represented by the trough of the curve, near which the focal length changes only slightly with color.

The aim in the design of achromatic doublets is not to bring two chosen colors to a common focus, but to choose a pair of colors for achromatization so that the minimum focus is brought into the spectral region for which the doublet will be used. For visual telescope objectives, this region is around 5550 angstroms, in the green, where the human eye is most sensitive. For photographic objectives, if color films or panchromatic films are used, the correction is in the same neighborhood. In general astronomical photography, where photographic emulsions with high sensitivity in the blue region of the spectrum are usually used, achromatization is often established for the D and G′ wave lengths. The question of where to achieve achromatization for various purposes is a complicated one.

For some applications, such as color photography and microscopy, achromatization for three colors may be necessary. In general, this requires three kinds of glass, although for some particularly happy combinations of materials (such as fluorite and certain special glasses) correction for three colors is possible with only two materials. A lens corrected for three colors is called **apochromatic.** How such a correction can be achieved is beyond the scope of this discussion.

The uncorrected smear of colors along the optical axis that results from ordinary achromatization is called the **secondary spectrum.** This effect, familiar as the purple border seen around a bright star or planet in a refracting telescope, becomes worse as the focal length of the lens increases. This makes it particularly

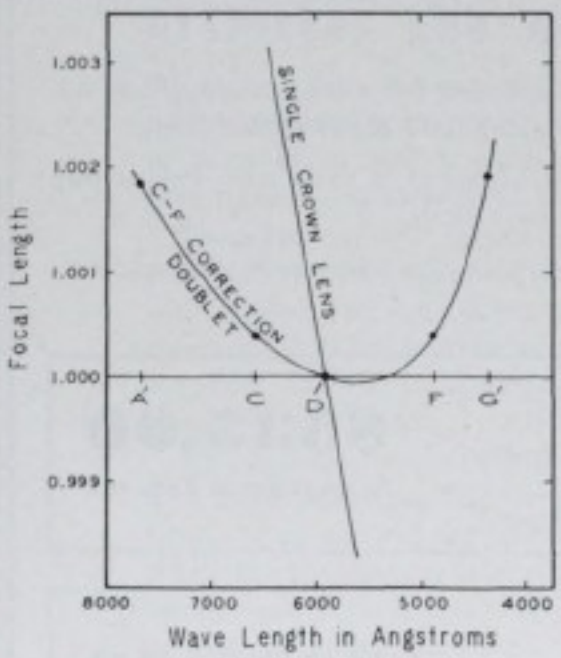

Fig. 49. The color curve of an achromatic lens that brings to a common focus F and C light (4861 and 6563 angstroms, respectively). The letters are the Fraunhofer designations of spectral lines. The intermediate wave length of the sodium D line is in the trough of minimum focus. The steepness of the color curve of a simple lens makes it clear why a nonachromatic objective is unsuited for astronomical telescopes.

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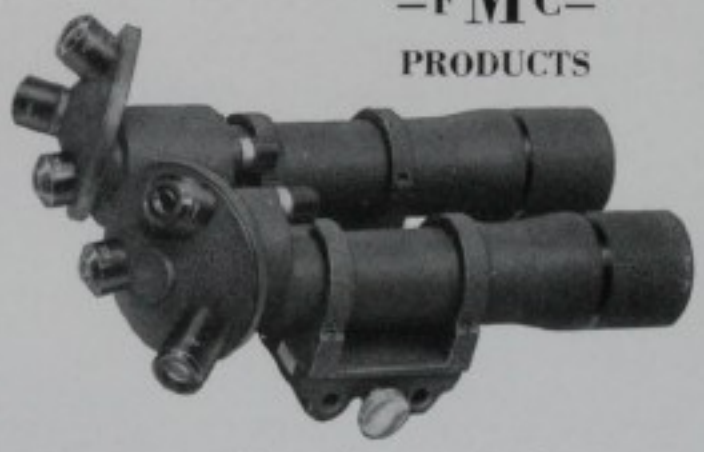

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troublesome in large astronomical refractors, such as the Yerkes and Lick telescopes, where it reaches rather large values in terms of millimeters of focal difference.

The analysis in our July article of chromatic aberration and its correction applies, of course, only to thin lenses and to paraxial conditions. In practice, the chromatic aberration of a lens is not completely independent of its aperture or thickness, and there is a variation of chromatic aberration with object and image distances. However, these variations are for the most part small compared to the primary chromatic aberration discussed previously, and they are not considered in the preliminary design of an optical system.

Actually, every aberration of a system varies with color. These effects are generally small, and need not concern us here. The variation of distortion with color, however, is often quite important, and leads to **chromatic difference of magnification,** or lateral color. This condition may also be regarded as a chromatic difference in the effective focal length of a lens (even when there is no chromatic difference of back focal length). Lateral color is a phenomenon that is particularly plaguing in eyepiece design.

(To be continued)

JUNIOR TELESCOPE KITS

INTEREST CONTINUES in the junior telescope kits for making an 8-power simple refractor, first developed for use in classes at the Cleveland Museum of Natural History. Here is news to supplement the note, "Junior Telescopes by Mail," in the April, 1954, *Sky and Telescope*, page 191.

I can remember when the president of the museum examined the prototype of the junior telescope in 1948. He asked how many would be required, and I said cautiously that 500 might be the total demand. In the middle of May, this year, the 1,499th kit was shipped to Johannesburg, South Africa, and on the same afternoon a Cleveland science teacher picked up two kits, so distribution went over the 1,500 mark that day.

During 1954, 169 persons wrote inquiring how to make a simple and inexpensive telescope. A total of 172 kits was ordered by 46 persons. In the first 4½ months of 1955, 132 kits were sent out, including orders for 40, 30, and 21 kits.

Recently, the supply of simple lenses around which the kit is designed was exhausted, but I have just purchased 1,000 sets from the American Optical Co. These are 37-mm., 343-mm. focal length lenses, and some of the drawings and other kit parts have had to be changed to match them. But the power is the same, and I can continue to supply these kits.

Single telescope kits, including 17 parts

and three lenses, with simple assembly instructions, are shipped postpaid for $3.00 each kit. Cartons of five kits ($12.50 per carton) and 10 kits ($22.50 per carton) are available when ordered by astronomy clubs, or others who are starting junior astronomy clubs sponsored by scout, school, church, museum, or other civic groups. An instruction manual set for teachers and leaders, at $1.00, includes eight charts and two illustrated 8-page manuals.

FRANK A. MYERS
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TRAVELING CLUB TELESCOPE

THE PORTABLE 6-inch f/7.3 reflector illustrated here was designed and constructed by the joint membership of the Bakersfield Amateur Astronomers, with the intent of lending it on a weekly basis to members not having instruments of their own.

The yoke and supporting frame are of select 2 x 4's, and the instrument can be leveled to uneven terrain by the adjustable supporting pads. All axes are ½" steel. The tube is 0.040" aluminum, with the mirror cell cast from aluminum-alloy piston material. The brass eyepiece holder is of the spiral focusing

The Bakersfield traveling telescope.

type. A prism is used as the secondary.

It is of a practical design for its intended use, very compact, sturdy, and yet light in weight. Two eyepieces and a Norton's *Star Atlas* accompany the telescope in its journey around the membership. The instrument and the superb observing conditions here at the southern tip of California's San Joaquin Valley are doing their share to promote astronomy as a hobby.

JAMES L. WILSON, president
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SPHEROMETER

For amateur or professional. 5" diam. ring, individually calibrated tables furnished, −6" to +6" radius measured. Guaranteed accuracy, ±.0002".

$22.50 postpaid

LOW-EXPANSION ELLIPTICAL DIAGONALS
Aluminized

Minor Axis	
¾"	$3.75
1"	3.75
1¼"	5.00
1½"	6.50

Free catalog sent on request.

NYE OPTICAL CO.
2100 Cherry Ave., Long Beach 6, Calif.

DELUXE PYREX
Reflecting Telescope Kits

Our kits have PYREX mirror blank, PYREX tool the same thickness, ample supply of optical quality abrasives, fast polishing cerium oxide, red rouge and pitch. Packed in metal cans.

Size	*Thickness*	*Price*
4¼"	¾"	$ 5.50
6"	1"	$ 9.50
8"	1½"	$17.00
10"	1¾"	$29.95
12½"	2⅛"	$52.95

ADD POSTAGE: 1st and 2nd postal zones from Detroit, add 5%; 3rd and 4th, add 10%; 5th and 6th, add 15%; 7th and 8th, add 20%. Or we will ship C.O.D.

Send for free catalog of supplies, accessories, and refracting telescopes.

ASHDOWNE BROS.
18450 Grand River Detroit 23, Michigan

SKY-SCOPE

COMPLETE AS ILLUSTRATED $29.75

The full 3½-inch diameter reflecting type astronomical telescope that even the telescope makers talk about.

It has been sold for more than 15 years and now is on display in at least two U. S. planetaria. It will show mountains and craters on the moon, Saturn's rings, Jupiter's four moons and the planet's markings, and close double stars with guaranteed observatory clearness. Skyscope enjoys worldwide distribution.

Every instrument, with its ¼-wave, aluminized mirror, is individually tested before being packed for shipment. We suggest that before buying you inquire at almost any local astronomy society about the efficiency of Skyscope. *100% American-made.*

We invite your attention to our free and straightforward descriptive brochure which also shows a photograph of the individual parts used.

125-power and 35-power extra eyepieces	$5.15 each
Six-power finder, with brackets	$7.50
Holder for extra eyepieces	$1.00

THE SKYSCOPE CO., INC. 475-s Fifth Avenue, New York 17, N. Y.

DAVIDSON *Telestar*

EYEPIECES AND ACCESSORIES

We have in stock for immediate delivery the finest quality eyepieces you can buy. These optics are made to precision standards and are identical to ones we have furnished to some of the large observatories.

These four-element eyepieces give a flat, beautifully corrected field of view. They are also Par Focal, which means that if an object is in focus with one eyepiece, it will also be in focus with different power eyepieces. Each is made with ample eye relief for those who wear glasses.

All eyepieces have hard-coated optics and come with metal dust caps. Telestar eyepieces are of the bayonet type and lock securely into an adapter tube with just one-quarter turn. They are made in 11mm., 16mm., and 22mm., focal lengths. All metal parts are black, anodized aluminum.

PRICES . . .	Each
Eyepiece with Cap (11mm., 16mm., 22mm. F.L.)	$15.00
Eyepiece and Focusing Mount	25.00
Adapter Tube only	3.50
Focusing Mount only	12.50

One of America's Finest Optical Plants

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ACHROMATIC TELESCOPE OBJECTIVES

4" (or more) Clear Aperture

Air-spaced in Bronze Mountings. 30", 40", 44", 48", 63", 84", or 96" e.f.l.

U.S. Navy surplus at less than 10% original cost. Strictly a limited supply. We will have to return your money if you are late in ordering. Don't delay! Made-to-order for lunar and planetary workers. These are not "surplus lenses." They were in use by the service for some years and were only replaced by more compact units. While they last, our price **only $59.00 each** plus express charges (collect).

NEW LARGER SIZE EQUATORIAL MOUNTING

Aluminum and steel

Weight 30 pounds. Height 15", width 17". Finished in grey lacquer. Will handle any telescope up to a 10" mirror with 11" diameter tube. All 1" diam. hollow steel bearings guaranteed against play. Every motion of the instrument will feel as smooth as silk. Clamping screws, ¼ x 32. Polar axis adjustable by two locking bolts. The telescope can be moved north-south in declination and east-west in time or right ascension to any part of the sky. There is enough extension on the shafts to attach clock drive or verniers.

COMPLETE $60.00 plus parcel post

3" ROSS STELLARSCOPE

40 and 80 Power

Improved Model—$16.50

Same principle as Mt. Palomar 200-inch Telescope. Exquisite definition. Knocked down.

Learn optical principles and astronomy and save money, too, by assembling your own 3" ROSS STELLARSCOPE.

Kit is complete (no lens polishing necessary) for just **$16.50** plus postage for 9 lbs. Add a Ross Quadripod (as illustrated) for only **$18.00** more.

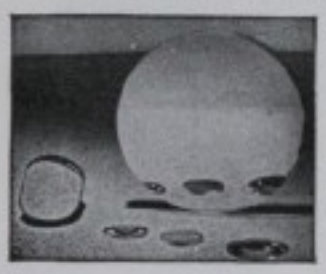
ACHROMATIC FINDER TELESCOPE

Uses a fine objective and eyepiece. With crosshair. High eye relief. 4 power. Weight one lb. Diameter 1" by 14" long. Complete with optics, metal tube with mounting brackets. Limited stock....**$7.75 plus postage**

STAR DIAGONAL

For the convenient observation of stars near the zenith, a prism is indispensable. It is placed before the eyepiece to direct the pencil of light rays so that the axis of the eye-lens is at right angles to the axis of the telescope. Our "Star Diagonal" is especially manufactured for this purpose. Fits standard 1¼" eyepiece holder and takes standard 1¼" eyepieces. Price, including fine quality light flint glass fluoride coated 1⅝" prism **$15.50**

Equivalent straight-tube length 4". Prism easily removed for cleaning.



5" Telescope Mirror 67" F.L., Ground, Polished, Aluminized, only **$13.00**

Overstocked Selling Out Special

Our regular 5" Aluminized Telescope Mirrors. 67" f.l. 1" blank, crown glass. Regular $17.00, while they last **ONLY $13.00 plus $1.00 P.P.**

Remit with order. Include postage. No C.O.D.

HARRY ROSS

Telescopes - Microscopes

Comprehensive Catalog — $1.00; Deductible from First $10.00 Purchase.

70 West Broadway, New York 7, N. Y.

A Surveyor's Transit You Can Build

A GOOD surveyor's transit costs about $600 and is well worth it. However, to teach boy scouts the fundamentals of surveying and map making, we built one for less than 10 dollars. You have to have access to a small metal lathe, be handy with tools, and be able to do some silver soldering.

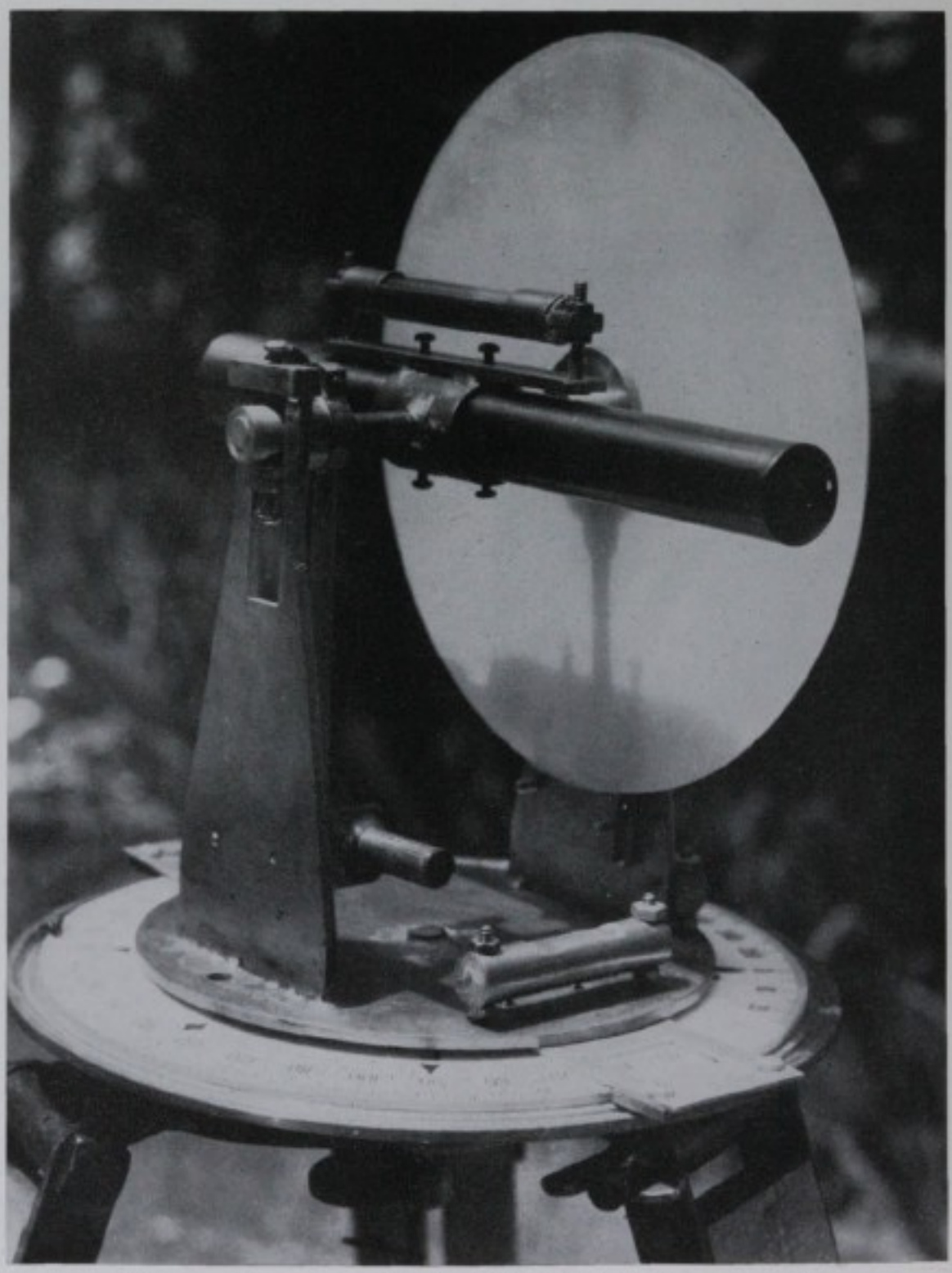
The transit is built around an Edmund war-surplus riflescope that I bought for about seven dollars. The three levels came from the same source, about 20 cents each, or can be taken from any instrument or device that is available. I had to mount the levels in brass tubes, and provide adjusting screws as shown in the diagram. The circles are war surplus or available from supply houses; mine cost $1.00 each from a New York concern.

The remainder of the instrument is made from brass sheeting, with cold-rolled steel for the axes, wood for the tripod, and odds and ends of bolts, nuts, and screws from my junk box.

As in instruments of European design, this transit has only three leveling screws. The vertical axis is single; hence it is not possible to measure horizontal angles by repetition as in the ordinary transit. The two opposing verniers enable us to read to 1/10 degree. It would not have been difficult to divide the verniers so angles could be read to two minutes of arc.

The horizontal axis has a clamp and tangent screw for slow motion. This is convenient but not necessary. Note that the telescope can be adjusted in its mounting and that one bearing is also adjustable. All levels are adjustable.

The telescope magnifies about two times, but it would be better if the lenses had been changed to give a magnification



The transit instrument built by John J. Ruiz for boy scout work.

Scout Gary Reynolds uses the transit.

of at least five diameters. The riflescope comes with complete instructions on how to do this.

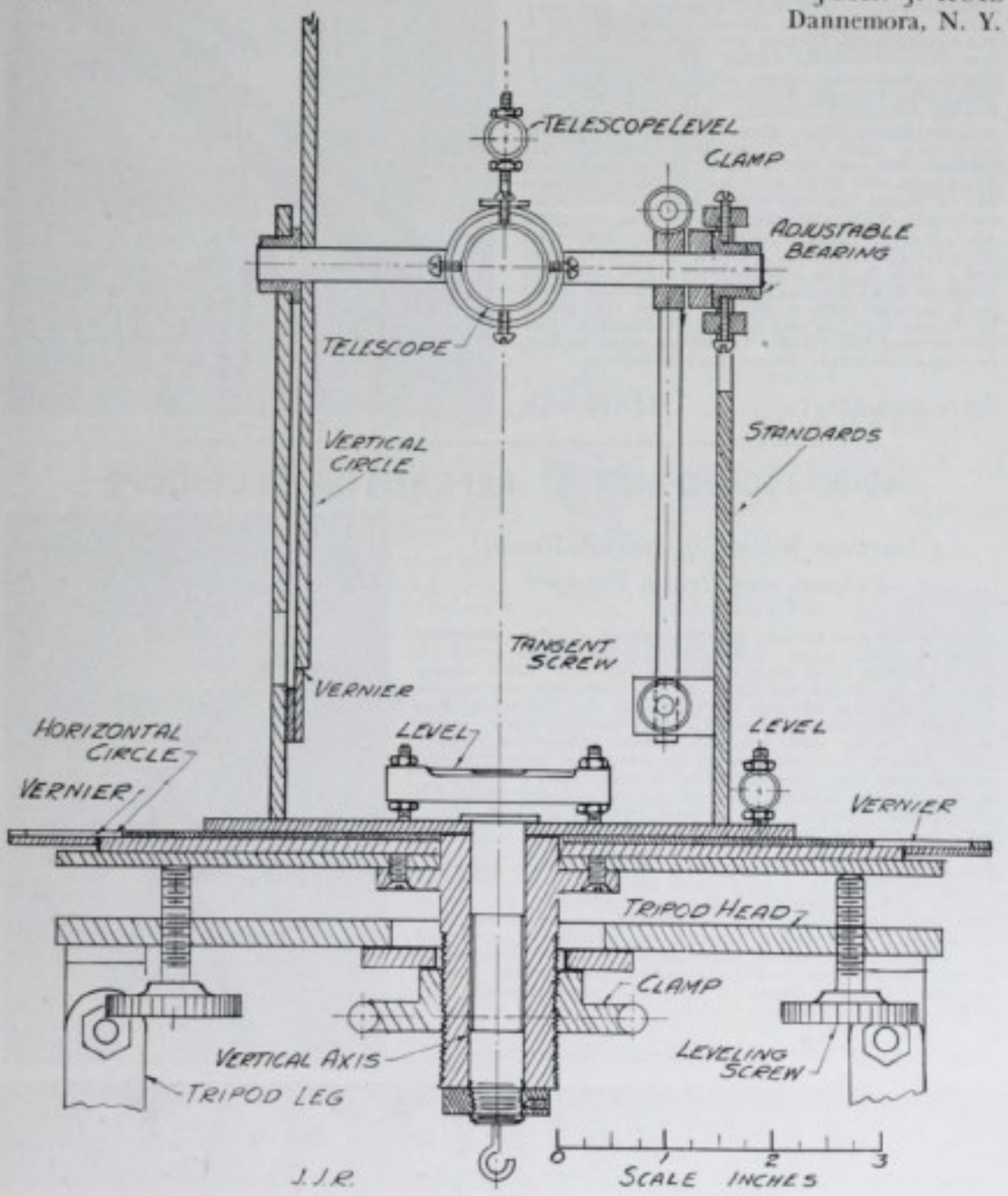
As to results: Six boy scouts were divided into groups of two, one acting as transitman and the other as rodman and recorder. A triangular field was selected and the angles measured. The error of closure came within 1/10 or 2/10 of a degree. One group hit it on the nose, 180°, by sheer accident. The height of a 220-foot chimney was measured with an error of about six inches, and one group came within two inches!

The transit was also used as a level to measure the difference in elevation between two points about 300 feet apart, the difference being about 10 feet. The error did not exceed 1/10 or 2/10 of a foot.

The boys did all of the desk work graphically, since none of them had had trigonometry. A more advanced class was taught how to adjust the axes and levels, and the use of tables to solve the triangles trigonometrically.

Of course, this instrument could be used for such other purely astronomical problems as determination of latitude, time, and azimuth. I did not try this with these boys, but I believe that an older group with sufficient background could have been instructed in these astronomical applications.

JOHN J. RUIZ
Dannemora, N. Y.



OPTICAL FLATS
Pitch Polished, Beral Coated.

Rectangular shape
1-3/8" x 1-7/8"
1/2 wave $1.75 ea.
1/4 wave $4.50 ea.
Postpaid.

Elliptical shape
Heavy edges to minimize temperature effects.
1¼" minor axis.
1/2 wave $4.00 ea.
1/4 wave $6.50 ea.
Postpaid.

BERAL COATINGS — same optical characteristics as aluminum — mechanically more durable — not overcoated — may be removed without harming glass surface. Prices for Beral coating telescope mirrors: 4" diam.-$2.75, 6"-$3.50, 8"-$4.50, 10"-$6.50 and 12½"-$9.75 each, f.o.b. Skokie.

LEROY M. E. CLAUSING
8038 MONTICELLO AVE. SKOKIE, ILL.

THE NEW GARTHOSCOPE 6-INCH REFLECTOR

- 6-inch Pyrex parabolic mirror correct to ¼ wave. Aluminized and quartz coated.
- Rack-and-pinion focusing.
- Seamless aluminum tube with baked black enamel.
- Brass setting circles.
- 8x coated achromatic finder.
- Three orthoscopic eyepieces.
- Massive equatorial mounting with slow motion control and tripod (sold separately for $175.00).
- COMPLETE, ONLY **$310.00.**

MIRROR CELLS

Made of light, sturdy aluminum, they furnish an ideal method of securing the mirror to the tube. They are spring adjusted to absorb shocks and cut away for ventilation.

6"-$7.00 8"-$11.50
10"-$35.00

EYEPIECE ATTACHMENT WITH RACK AND PINION

Takes standard 1¼" O.D. eyepieces. Rack and pinion smoothly machined from solid aluminum castings. Precisely fitted for smooth performance. Main tube is 1¾" long; sliding tube adds 2"; total movement 3¾". Your choice of gray or black crinkle finish.

$15.50

BUILD YOUR OWN TELESCOPE
Prisms Lenses Eyepieces
Mirrors ground to your order.
Aluminizing—with Quartz Coating
Satisfaction Guaranteed
Write for Free Catalog

GARTH OPTICAL COMPANY
G. P. O. Box 954 New York 1, N. Y.

WHAT'S NEW AT EDMUND'S

by Norman W. Edmund

Dear Fellows:

For those who are interested in optics in general, I would like to call your attention to some of our small instruction booklets. We are constantly adding new titles and have listed the newest ones first.

Booklet	*Stock No.*	*Price*
How to Condense and Project Light with Lenses	9044-Y	.75
Reticles and Their Uses	9039-Y	.45
Infra-Red Light and Its Uses	9042-Y	.60
Experimenting With Photo-electric Cells	9041-Y	.50
Ronchi Rulings and Their Uses	9043-Y	.30
Homebuilt Riflescopes	9018-Y	.40
Ultra Close Up Photography	9042-Y	.60
All About Telephoto Lenses	9036-Y	.60

Of special interest will be the fact that the booklet on infra-red has plans in it for an infra-red eyepiece for astronomical telescopes. We have the British infra-red tube and also war surplus infra-red filters.

We have been successfully mounting our 3" and 4¼" mirrors, also diagonal mirrors, with double-faced adhesive tape. The amateur without a metal shop can save himself a lot of mounting headaches by using this tape for mounting flat items together. We sell a piece 4" x 12", Stock No. 60,038-Y, for 90c postpaid.

PALOMAR, JR. EQUATORIAL MOUNT

This mount will help you find and "follow" a star with a minimum of effort! Point the polar axis at the North Star, adjust the tripod legs for its elevation, and tighten the lock nut. The telescope tube will now describe the same arc as a heavenly body moving through the sky.

Supplied complete with tripod legs for reflectors or refractors up to 4¼" diam. The taller tripods are used for refractors. Made of hardwood. Same mount supplied with either tripod.

Stock #85,009-Y
(Tripod legs 40" long) ..... $18.95 f.o.b.

Stock #85,015-Y
(Tripod legs 60" long) ..... $22.50 f.o.b.

6" REFLECTING TELESCOPE

Complete with heavy duty equatorial mounting and tripod. Triped has cast aluminum head and rugged wooden legs for stability. (Folds for storage.) Equatorial mount has 1" diameter shafts with Boston bronze bearings. 5-lb. counterweight for perfect balance. Locks on both declination and polar axis. Polar axis set at 40°; latitude adjustment made with tripod legs. Black crinkle finish on mount. Telescope tube made from plastic impregnated fibre. White enamel finish on outside. Rack-and-pinion focusing eyepiece mount. 7X achromatic finder with crossline reticle. 6" Pyrex parabolic mirror—48" F.L. (f/8)—aluminized and overcoated—guaranteed to give theoretical limit of resolution. Mirror mount machined cast aluminum. Kellner eyepiece gives you 40X and a Gojo combination eyepiece gives 60X and 120X. A Barlow lens is included to give 150X and 300X. Shipping weight 75 lbs.

EXCEPTIONAL VALUE!

A Truly Fine Instrument—

40X, 60X, 120X, 150X, 300X.

Stock #85,024-Y ..... $245.00 f.o.b.

6" & 8" EQUATORIAL MOUNT

As Illustrated on 6" Telescope Above

Heavy ⅜" steel plate base with five ½" holes for attaching to your post or tripod. Welded construction throughout. One-inch shaft with Boston bronze bearings. Bearings and housing 6" long. 5-lb. counterweight for balance on 16"-long shaft. 1¾" diameter locking knobs on both declination and polar-axis shaft. Polar axis set at 40°; latitude adjustment made with tripod legs. 14" cradle securely holds from 4" to 10" diam. telescope tubes. Mount weighs 27 lbs. and is approximately 14" high.

Stock #85,023-Y ..... $49.50 f.o.b. Barrington, N. J.

3" REFLECTOR ASTRONOMICAL TELESCOPE KIT

Complete parts—no machining—easily assembled; a nine-year-old can do it! All nuts and bolts supplied. Nothing extra to buy. Kit includes 3" spherical mirror 30" F.L., aluminized and overcoated. Guaranteed to resolve detail right up to theoretical limit. Tripod 40" high with cast-iron tripod head, all holes drilled and tapped (all machining finished). Other parts made from ⅛" thick steel all ready to assemble. Smoothly functioning equatorial mounting. Locks on both polar and declination axes. Polar axis at 40°; latitude adjustment made with tripod legs. Natural grain finished hardwood tripod legs. Heavy wall black kraft telescope tube with special black glare-reducing liner. Eyepiece mount has slide focus adjustment. Mirror attaches on new type mounting with pressure-sensitive adhesive tape eliminating distortions. Mirror is ventilated. 60X eyepiece and a 100X Barlow lens included. 90X and 120X eyepieces available at extra cost. Crosshair finder parts included with mountings. Parts zinc plated to prevent rust. A real kit in every respect. Can also be used terrestrially. Nothing extra to buy. Directions included! Money back guarantee.

Stock #85,025-Y ..... $29.50 f.o.b.

40-90-190 POWER 3" REFRACTOR TELESCOPE

Complete With Equatorial Mount, Tripod and Prism Finder!

Here's a telescope bargain that uses the 3" objective described on the opposite page. Telescope is complete—no extras to buy. Look at all of these wonderful features. Erect image. Roof prism. Bends the light at 90° angle for comfortable viewing at zenith and also for terrestrial use. Three eyepieces supplied with the telescope: 6.0 mm. for high-power astronomical viewing, 12.5 mm. for medium power for viewing moon, planets, etc., and 28 mm. for low-power terrestrial and astronomical use. Small focusing eyepiece mount takes 1¼" outside diameter eyepieces. Contains built-in filters which can be changed by turning a small knob. Filters are red, yellow, neutral, and clear for use in planetary work.

The 8-power finder telescope has a real achromatic objective. Bends the image in a right angle for convenience in transferring your eye from the finder to the telescope. The heavy-duty equatorial mount can be adapted for all latitudes in astronomical viewing. It is quick and flexible for terrestrial use. Specially designed to adapt easily to slow-motion mechanism. Heavy-duty tripod adjustable for viewing at all heights. Overall length of telescope approximately 45". Shipping weight 100 lbs.

Stock #85,019-Y ..... $195.00 f.o.b. Barrington, N. J.

EDMUND SCIENTIFIC CORP.

ACHROMATIC ASTRONOMICAL TELESCOPE OBJECTIVES

Real Quality at Bargain Prices Make Wonderful Refractors

For three years we checked U.S., German, and Japanese manufacturers looking for one who could produce really good telescope objectives at a low price. A few times we ordered samples only to be disappointed in quality or final price. Finally, we found a Japanese optical engineer who designed some excellent astronomical objectives. We place orders with him. He then has these made, checking each one for quality. Thus, we are able to offer objectives we believe to be as good as those selling for two or three times our price.

Our 3" and 4" diameter objectives are air-spaced achromats, as air-spacing gives the lens designer four surfaces with which to correct aberrations, instead of only three as in a cemented achromat. The results are a beautiful, color-free image, sharp, clear, with very flat field, no bad zones, and full correction against coma.

Stock No.	Diam.	F.L.	Price	Comments
30,166-Y	3"	45"	$28.00	Not coated
50,106-Y	4"	60"	60.00	Not coated
50,107-Y	4"	60"	69.00	Coated on four surfaces

We supply free with the 3" objective a specially designed, spiral-wound kraft board mount which is designed to slip over aluminum tubing.

For the 4" objective, a metal cell is available for $11.95. Order Stock No. 70,063-Y. This cell has a 4" I.D. and fits over our 4" O.D. aluminum tubing.

Rack & Pinion Eyepiece Mounts

For Reflectors

For Refractors

Now you can improve performance in a most important part of your telescope — the eyepiece holder. Smooth, trouble-free focusing will help you to get professional performance. Look at all these fine features: Real rack-and-pinion focusing with variable tension adjustment; tube accommodates standard 1¼" eyepieces and accessory equipment; lightweight aluminum body casting; focusing tube and rack of chrome-plated brass; body finished in black wrinkle paint. No. 50,077-Y is for reflecting telescopes, has focus travel of over 2", and is made to fit any diameter or type tubing by attaching through small holes in the base. Nos. 50,103-Y and 50,108-Y are for refractors and have focus travel of over 4". Will fit our 2⅞" I.D. and our 3⅞" I.D. aluminum tubes respectively.

Stock #50,077-Y (less diagonal holder) $9.95 ppd.
Stock #60,035-Y (diagonal holder only) 1.00 ppd.
Stock #50,103-Y (for 2⅞" I.D. tubing) 12.95 ppd.
Stock #50,108-Y (for 3⅞" I.D. tubing) 13.95 ppd.

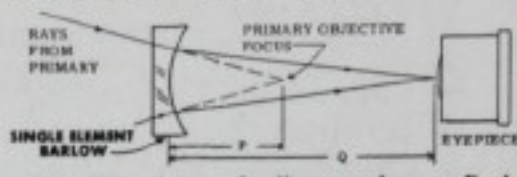
HUYGENS EYEPIECES

Here are some really terrific values in eyepieces! The three eyepieces listed below are manufactured by one of the world's best producers of optical components. We have searched the world's markets, including Germany and France, to find a real quality eyepiece. The image clarity, the workmanship evidenced in the metal parts, will prove the skill and experience of Goto Optical Company, Tokyo. Guaranteed terrific buys at these low prices!

HUYGENS TYPE — STANDARD 1¼" DIAM.
6 mm. (¼") Focal Length
Stock #30,063-Y ..... $8.50 ppd.
12.5 mm. (½") Focal Length
Stock #30,064-Y ..... $8.00 ppd.

COMBINATION EYEPIECE—10 mm. and 20 mm.
Stock #30,065-Y ..... $9.00 ppd.

DOUBLE AND TRIPLE YOUR TELESCOPE'S POWER with a BARLOW LENS



WHAT IS A BARLOW? A Barlow lens is a negative lens used to increase the power of a telescope without resorting to short focal length eyepieces, and without the need for long, cumbersome telescope tubes. Referring to the diagram above, a Barlow is placed the distance P inside the primary focus of the mirror or objective. The Barlow diverges the beam to a distance Q. This focus is observed with the eyepiece in the usual manner. Thus, a Barlow may be mounted in the same tube that holds the eyepiece, making it very easy to achieve the extra power.

The new power of the telescope is not, as you might suppose, due to the extra focal length given the objective by the difference between P and Q. It is defined as the original power of the telescope times the quotient of P divided into Q!

ACHROMAT OR SIMPLE BARLOW? An achromatic Barlow lens will give best results, but our low-priced single-element lens will give you 90% of the performance of the achromat. In fact, on and around the axis, the image will be just as good, with slight additional color at the edges of the field. SINGLE ELEMENT BARLOW — FOCAL LENGTH 1-5/16".

Our short focal length means that you do not have an unwieldy long tube at the eyepiece.

Stock #30,175-Y. Unmounted, O.D. 1-3/16". Coated. Fits in tubing listed below. $3.00 ppd.
Stock #30,140-Y. Mounted Achromatic Barlow Lens ..... $15.00 ppd.

30-day Money Back Guarantee as with all our Merchandise!

BRASS TUBING

2 pieces, 3" long, slide fitting. Blackened brass. I.D. 1-3/16", O.D. 1-5/16". To fit single-element Barlow above.
Stock #40,165-Y ..... $1.25 ppd.

7X — FINDER TELESCOPE — ACHROMATIC

Stock #50,080-Y Finder alone, less ring mounts $9.95
Stock #50,075-Y Ring mounts per pr., $4.95

ASTRONOMICAL TELESCOPE TUBING

Stock No.	I.D.	O.D.	Lgth.	Description	Price
80,028-Y	4⅞"	5¼"	46"	Spiral-wound paper	$2.50
85,008-Y	7"	7½"	60"	Spiral-wound paper	4.00
85,011-Y	2⅞"	3"	48"	Aluminum	6.00
85,012-Y	3⅜"	4"	60"	Aluminum	8.75
85,013-Y	4⅞"	5"	48"	Aluminum	9.00
85,014-Y	6⅞"	7"	60"	Aluminum	15.00

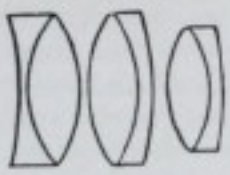
All tubing is shipped f.o.b. Barrington, N. J.

MOUNTED ERFLE EYEPIECE

68° FIELD OF VIEW

Consists of 3 coated achromats in metal mount with spiral focusing. F.L. 1¼". Diam. 54 mm., length 54 mm. War surplus. Govt. cost about $84.00. This is the type war surplus bargain that will be talked about in years to come. Buy while you can.

Stock #5160-Y, $12.50 ppd.



ADAPTER

Provides 1¼" diameter mount to fit standard eyepiece holders.

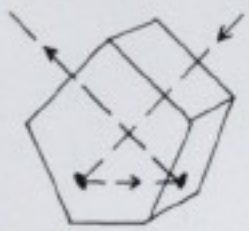
Stock #30,171-Y ..... $3.95 ppd.
1¼" diam.

WAR SURPLUS TELESCOPE EYEPIECE

Mounted Kellner Eyepiece, Type 3, 2 achromats, F.L. 28 mm., eye relief 22 mm. An extension added, O.D. 1¼", standard for all types of telescopes. Govt. cost $26.50.

Stock #5223-Y, $5.95 ppd.

MAKE A SUN DIAGONAL



Because it is unsilvered, this PENTA PRISM transmits only .0016 of the light it receives, making it an excellent sun viewing diagonal, if used with proper precautions. Entrance and exit faces 1" and 1" approximately.

Stock #3262-Y $3.75 ppd.

"MAKE-YOUR-OWN" 4¼" MIRROR KIT

The same fine mirror as used in our Palomar, Jr., polished and aluminized, lenses for eyepieces and diagonal. No metal parts.

Stock #50,074-Y ..... $16.25 ppd.

LATEST MODEL SPITZ Jr. PLANETARIUM

Designed by Armand Spitz. Projects nearly 400 stars, more than 70 constellations in their correct relationships. Use it in any darkened room of the house, project it on walls and ceiling. No batteries, works on ordinary household current. Two simple adjustments that show you the sky as it appears from any point in the Northern Hemisphere . . . for any time of night . . . for any month of the year! Rheostat brightness control. A 32-page book included free of extra cost. Contains valuable information about the stars, provides easy identification of the constellations. Also FREE — illuminated pointer.

About 14" high on a 7" x 7" base. Projection sphere 7" diameter. Weight 3 lbs. Now available supplementary spheres for Southern Hemisphere and "Sky Zoo."

Stock #70,040-Y ..... $14.95 ppd.

SPHERICAL TELESCOPE MIRRORS

Ground, polished, aluminized, silicon monoxide overcoated. You can't buy better quality. Remember, good Spherical Mirrors of f/10 and higher, are perfectly satisfactory for reflecting telescopes.

STOCK NO.	DIAM.	F.L.	PRICE
50,082-Y	3"	30"	$9.95
50,051-Y	4¼"	45"	15.00

360° SETTING CIRCLE

Made of heavy black plastic material with white markings divided into 1 degree. Numbered every 10 degrees. Diameter 4". Hole diameter 2⅞" with a ledge 3⅛". We also include, free of charge, the U.S. Air Force true air-speed computer, which is an instrument made of two disks of black plastic. Use with the setting circle if you make your own.

Stock #60,039-Y ..... $1.25 ppd.

MISCELLANEOUS ITEMS

STAR SPECTROSCOPE — Imported! Doubles the usefulness of your Telescope. 2¾" long.
Stock #50,023-Y ..... $32.75 ppd.

60° SPECTROMETER PRISM — Polished surfaces 18 mm. x 30 mm. — flat to ½ wave length.
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OBSERVER'S PAGE

Universal time is used unless otherwise noted.

Photographing Comet Mrkos

SUNDAY, June 19th, was the date of the annual picnic of the Milwaukee Astronomical Society. It was the day we first saw Harvard Announcement Card 1299, which told of the presence of a bright comet in the northern sky—Comet Mrkos (1955e).

Plans were at once made to photograph the comet with the 13-inch f/8 reflector of the society's observatory. Our purpose was twofold: to get plates from which positions of the comet could be measured, and pictures to show its tail.

The telescope has an excellent drive. The plateholder is of the double-slide type, with a guiding eyepiece. This eyepiece is fitted with a "comet screw" to shift the crosshairs, so that one can guide on a star while photographing a moving object like a comet or asteroid. The emulsions we use are Kodak Spectroscopic 103a-O (blue) and 103a-E (red).

For each plate the essential record includes plateholder number (if more than one holder can be loaded at one time); date; beginning and ending times (to the nearest second); setting circle readings; emulsion; position of the plate relative to the optical axis; and pertinent remarks.

Plates to be used for measures of position must be of short exposure, so the star images stay small enough for accurate measurement and the comet does not show trailing. For positional work, the times of the exposure must be accurately known, and for this purpose we receive the Bureau of Standards time signals broadcast by short-wave Station WWV.

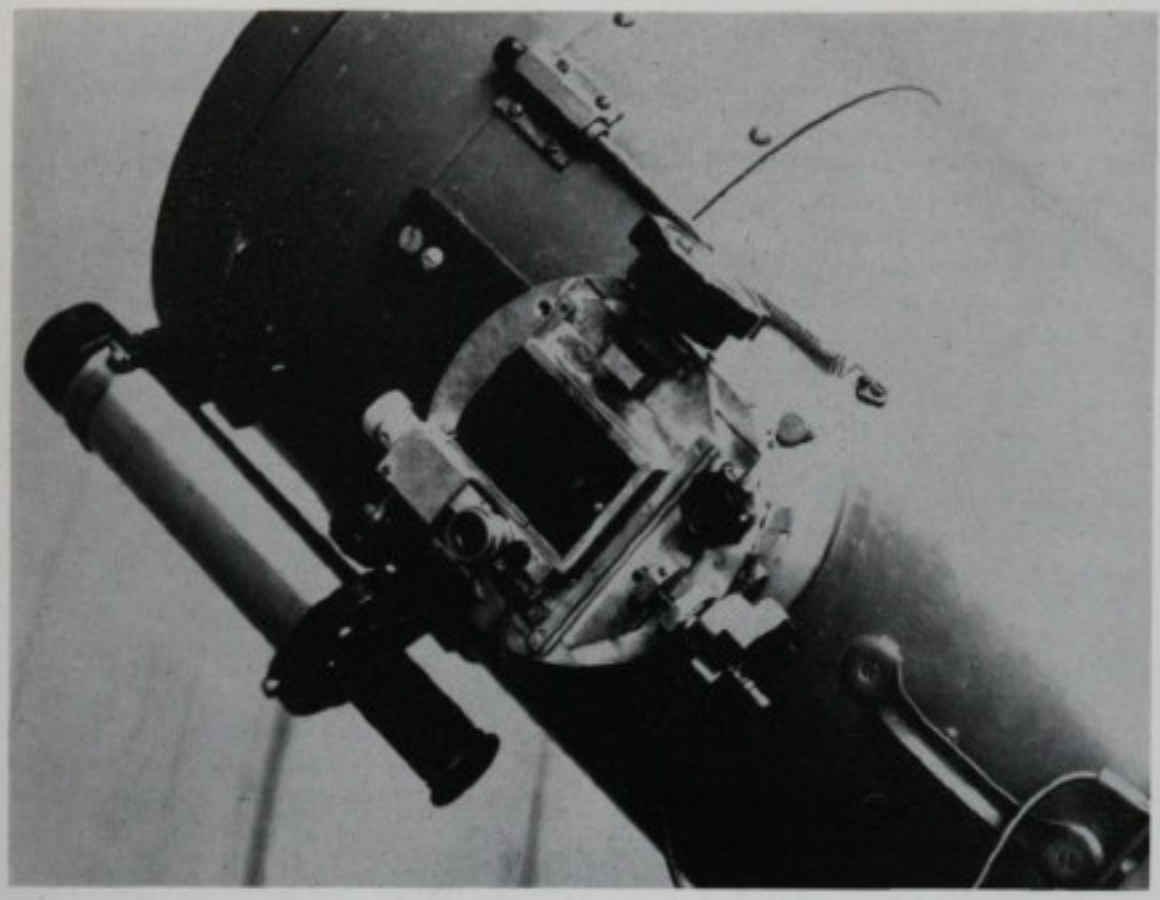
Two of our position plates are now being measured by a professional astronomer. Afterward, we will compute the right ascensions and declinations of the comet from these measurements. The two plates were exposed for four minutes, and 40 seconds, respectively. This difference was intentional, for the surrounding stars were much fainter than the comet on the four-minute plate, and about as bright as the comet for the 40-second plate. A third, with a 10-minute exposure, could not be used for position, as the comet had moved so much that the image of the head was elliptical.

To guide on the comet, Mr. Konig (left) is using the slow motions while Mr. Fink turns the comet screw.

The longer-exposure plates needed to show the tail of the comet require a little more work than just exposing. Comet Mrkos was moving northeast rapidly. We first took two pictures 30 minutes apart and developed them immediately. Superimposing these on a sheet of white paper, we drew in the north-south direction and a line connecting the centers of the two comet images. This line then indicated the direction of the comet's motion. The distance between the centers of the comet images was measured very accurately, and the movement converted to inches per second of time.

We knew what fraction of an inch one turn of the comet screw shifts the guiding eyepiece relative to the plateholder. Simple arithmetic then told how often the screw must be given a turn to compensate for the comet's motion. The

The rapid motion of the comet shows in these photographs by Richard Fink and William Konig, made June 23rd at (left to right) 5:42, 6:28, and 6:50, Universal time. The comet passed very near to a star in the last picture.



The plateholder and guiding devices are seen here. Conspicuous knobs are for slow motions and focusing; near the finder is the knob for the comet screw.

plateholder was then set so the comet's motion was parallel to the motion of the guiding eyepiece when the comet screw was turned.

Just before the shutter was opened for the exposure, a star was brought to the crosswires of the guiding eyepiece. At the proper intervals, the screw was turned, moving the star away from the wires. The slow motions on the plateholder were then turned to bring the star back to the crosswires by moving the plate itself.

With this method the comet image is stationary on the plate and the star images are slightly trailed. For the tail photograph reproduced here the screw was turned at a rate of 6.35 seconds per revolution. One person cannot easily turn the screw so rapidly and also operate the slow motions, so both authors worked together. For slow-moving comets, one person could manage everything alone.

The comet photographs with this article were taken on the night of June 22-23. The following night we planned to take plates but were clouded out. Did anyone happen to photograph Comet Mrkos then? If you did, examine your negative carefully and you may see 12th-magnitude Comet Baade (1954h) in the same field. On June 23-24, Comet Baade was only about 1½° north of Comet Mrkos, and for a while must have been occulted by the tail of the latter.

RICHARD R. FINK
and WILLIAM G. KONIG
Milwaukee Astronomical Society

The authors took this 20-minute exposure of Comet Mrkos in blue light, June 23rd, 7:50 UT. It is enlarged 4½ times.

COMET MRKOS (1955e)

As reported on page 436 last month, Comet Mrkos was already receding from the earth and the sun when it was discovered on June 12th, and consequently this object has been fading steadily. Dr. G. Van Biesbroeck, of Yerkes Observatory, estimated the total magnitude of the comet as 7.0 on July 10th, from out-of-focus comparisons with stars in a small telescope. On a photograph he took

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the same night, with the Yerkes 24-inch reflector, the slender tail was about two degrees long. In the days just after discovery the comet's tail appeared at least four or five degrees in length, in spite of the fact that the comet could then be seen only during twilight.

Excellent photographs of Comet Mrkos have been taken by Dr. S. R. B. Cooke, at Minneapolis, Minn., with his f/3.1 Schmidt camera. This has a 6-inch correcting plate and a 10-inch mirror; the guide telescope is a 12-inch Newtonian reflector. At a time when the comet was 6th magnitude, Dr. Cooke used a 20-minute exposure on Super XX film, with development for 7½ minutes in D19.

In September, the conditions of visibility of this comet should deteriorate rapidly. At the beginning of the month it will be about magnitude 10 and near Arcturus; it will be moving southward fairly rapidly, becoming closer to the sun in the sky as it fades.

OCCULTATION PREDICTIONS

September 2-3 **Kappa Piscium** 4.9, 23:-24.6 +1-00.5, 16, Em: **A** 9:22.4 −0.1 +3.3 181; **B** 9:28.4 −0.4 +1.4 199; **D** 9:23.3 −0.4 +1.8 196; **E** 9:10.4 −0.5 +2.2 194; **H** 8:32.2 −1.6 +1.4 230; **I** 8:37.6 −1.8 +0.2 266.

September 7-8 **A Tauri** 4.5, 4:02.0 +21-57.6, 22, Im: **A** 9:23.8 −2.0 −0.5 105; **B** 9:21.2 −1.8 +0.1 93; **C** 9:16.2 −2.3 −0.9 115; **D** 9:10.3 −1.8 +0.3 95; **E** 8:48.1 −1.7 +0.7 95; **F** 8:32.6 −2.0 −0.2 115; **H** 8:14.8 −0.3 +1.6 68; **I** 8:43.1 +0.2 +2.7 31. Em: **E** 10:01.6 −1.6 +1.7 238; **F** 9:30.0 −0.9 +3.2 213; **H** 9:18.4 −0.9 +1.3 260; **I** 9:26.8 −1.2 +0.4 302.

September 9-10 **Eta Geminorum** f 3.2-4.2, 6:12.2 +22-31.3, 24, Im: **F** 11:45.9 −2.0 +2.0 63.

September 10-11 **Zeta Geminorum** 3.7-4.1, 7:01.4 +20-38.3, 25, Im: **C** 6:53.4 . . . 24. Em: **C** 7:13.6 . . . . 342.

For stations in the United States and Canada, usually for stars of magnitude 5.0 or brighter, data from the *American Ephemeris* and the *British Nautical Almanac* are given here, as follows: evening-morning date, star name, magnitude, right ascension in hours and minutes, declination in degrees and minutes, moon's age in days, immersion or emersion; standard station designation, UT, **a** and **b** quantities in minutes, position angle on the moon's limb; the same data for each standard station westward.

The **a** and **b** quantities tabulated in each case are variations of standard-station predicted times per degree of longitude and of latitude, respectively, enabling computation of fairly accurate times for one's local station (long. **Lo**, lat. **L**) within 200 or 300 miles of a standard station (long. **LoS**, lat. **LS**). Multiply **a** by the difference in longitude (**Lo** − **LoS**), and multiply **b** by the difference in latitude (**L** − **LS**), with due regard to arithmetic signs, and add both results to (or subtract from, as the case may be) the standard-station predicted time to obtain time at the local station. Then convert the Universal time to your standard time.

Longitudes and latitudes of standard stations are:

A	+72°.5,	+42°.5	**E**	+91°.0,	+40°.0
B	+73°.6,	+45°.5	**F**	+98°.0,	+31°.0
C	+77°.1,	+38°.9	**G**	Discontinued	
D	+79°.4,	+43°.7	**H**	+120°.0,	+36°.0
			I	+123°.1,	+49°.5

VARIABLE STAR MAXIMA

September 2, RR Scorpii, 165030, 6.0; 4, R Sculptoris, 012233, 5.8; 5, SS Virginis, 122001, 6.9; 9, R Canum Venaticorum, 134440, 7.7; 9, RV Sagittarii, 182133, 7.8; 10, R Bootis, 143227, 7.3; 11, R Virginis, 123307, 6.9; 11, S Gruis, 221948, 7.8; 14, T Centauri, 133633, 6.1; 15, R Aquilae, 190108, 6.3; 16, R Andromedae, 001838, 7.0; 17, T Cephei, 210868, 5.8; 18, RT Hydrae, 082405, 7.6; 19, R Horologii, 025050, 6.0; 19, RU Cygni, 213753, 8.0; 19, S Pegasi, 231508, 8.0; 21, V Cassiopeiae, 230759, 7.9. October 1, T Columbae, 051533, 7.6; 2, X Centauri, 114441, 7.8; 5, S Carinae, 100661, 5.7.

These predictions of variable star maxima are by the AAVSO. Only stars are included whose mean maximum magnitudes are brighter than magnitude 8.0. Some, but not all of them, are nearly as bright as maximum two or three weeks before and after the dates for maximum. The data given include, in order, the day of the month near which the maximum should occur, the star name, the star designation number, which gives the rough right ascension (first four figures) and declination (bold face if southern), and the predicted magnitude.

MINIMA OF ALGOL

September 3, 1:06; 5, 21:55; 8, 18:43; 11, 15:32; 14, 12:20; 17, 9:09; 20, 5:58; 23, 2:47; 25, 23:36; 28, 20:24. October 1, 17:12; 4, 14:01; 7, 10:50; 10, 7:39.

These minima predictions for Algol are based on the formula in the 1953 *International Supplement* of the Krakow Observatory. The times given are geocentric; they can be compared directly with observed times of least brightness.

UNIVERSAL TIME (UT)

TIMES used on the Observer's Page are Greenwich civil or Universal time, unless otherwise noted. This is 24-hour time, from midnight to midnight; times greater than 12:00 are p.m. Subtract the following hours to convert to standard times in the United States: EST, 5; CST, 6; MST, 7; PST, 8. If necessary, add 24 hours to the UT before subtracting, in which case the result is your standard time on the day preceding the Greenwich date shown.

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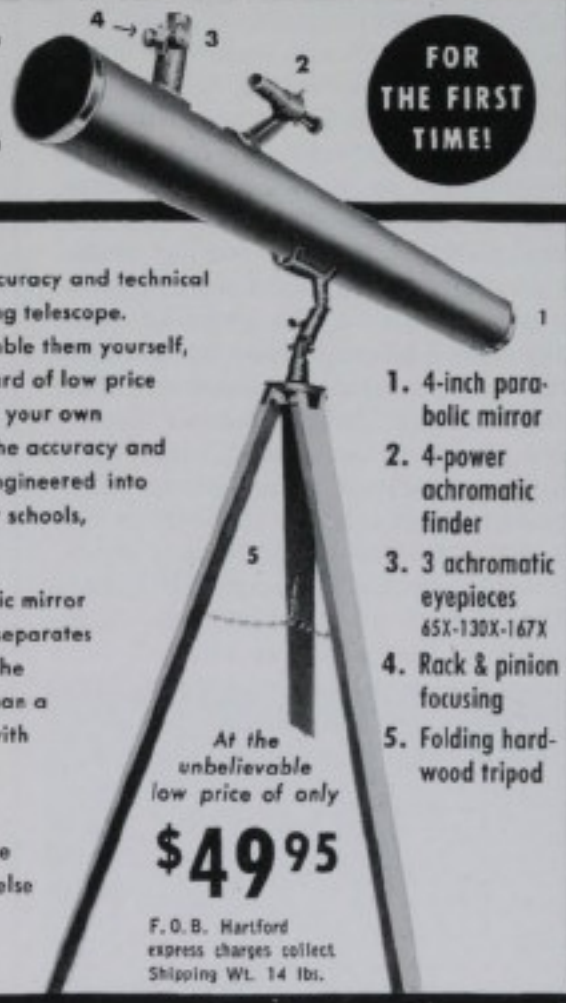

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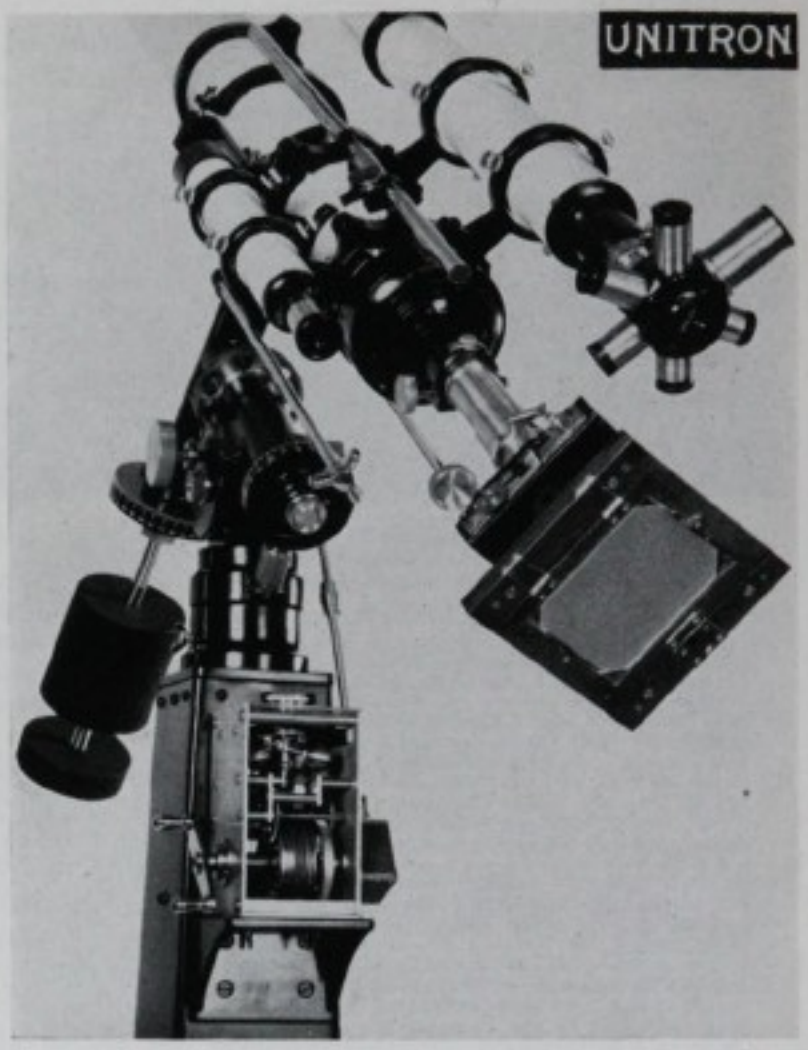

When this at-the-controls photograph of the new UNITRON 4" Photo-Equatorial Model 166 was first shown on the back cover, the aperture was mentioned only in small print and a surprising number of readers assumed it was a picture of our forthcoming 6" model. This mistake was entirely natural in that such a wealth of features and such massive design are not customarily found in a 4" refractor.

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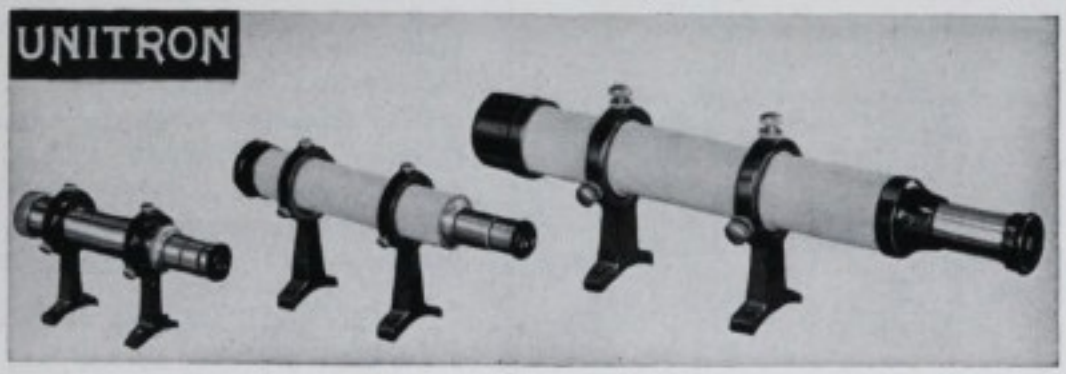

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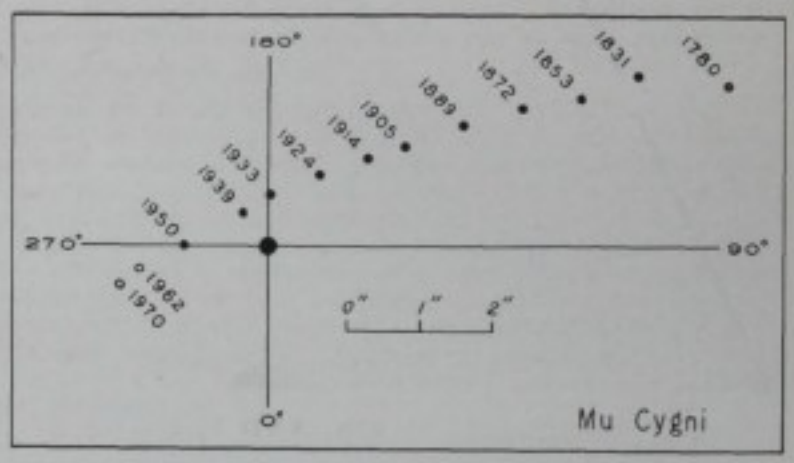
DEEP-SKY WONDERS

I LONG believed that the 20th-century amateur cared but little for double stars. My recent mail has completely corrected that opinion. Long lists of doubles are observed by many amateurs today, some of whom have the skill of the best of the 19th-century amateurs. This month we list two famous double star systems of more than usual interest.



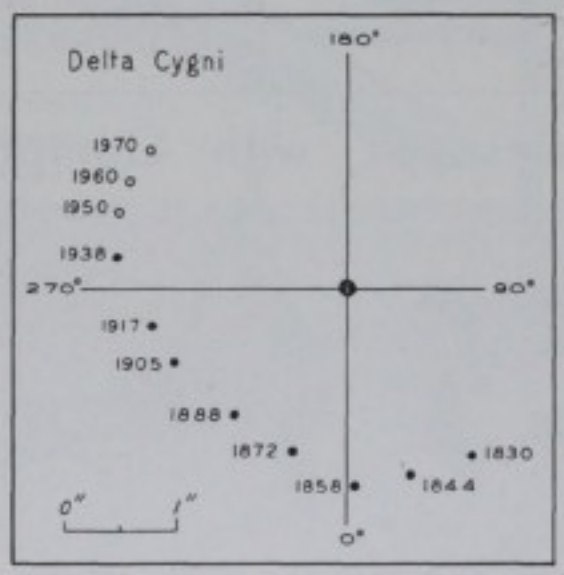
The double star Mu Cygni is now a much closer pair than when it was first observed in 1780. Dots and circles are observed and predicted positions, respectively, of the companion relative to the bright primary star.

Delta Cygni, at 19ʰ 43ᵐ.4, +45° 00′ (1950), is a well-known visual binary whose components are magnitudes 3.0 and 7.9. The present position angle and separation of the companion are 248° and 2".10, respectively. There is still some uncertainty as to the orbit of this pair; alternative periods of 371 and 537 years recently proposed by M. A. Gianuzzi lead to nearly identical predictions for the next few years. Because of the large magnitude difference, the companion is difficult and demands good optics and good seeing. In 1825, James South could not see the companion on a first-class night with powers up to 787 on a 5-inch refractor, when the distance was about 1".8. Today, a good 6-inch refractor should probably split this pair.

In some respects Mu Cygni is easier, as the magnitudes, 4.7 and 6.1, are more nearly equal, even though it is a closer pair. Its 1950 co-ordinates are 21ʰ 41ᵐ.9, +28° 31′, and the position angle and distance are now 274° and 1".45, respectively. For many years after William Herschel's first measurements in 1780, it was uncertain whether Mu Cygni was really a binary system, but recent measures leave no doubt. The orbit computed by N. V. Komendantoff in 1936 gives the period as 514 years. When the two stars were closest in 1937, the separation was only 0".54, and the pair was too difficult for most amateurs. It is now widening rapidly, and a good 6-inch should split it easily.

I am especially interested in learning what amateur reflectors will do with these two rather difficult objects. A postcard will be welcome, addressed to me at 907 Osage St., Manhattan, Kans., especially if it lists the aperture, focal length, powers used, type of spider, and whether a Barlow lens was employed.

WALTER SCOTT HOUSTON



Orbital motion of the companion of Delta Cygni is clearly shown by selected measurements from 1830 to 1938. Open circles indicate predicted positions. The brighter star is represented by the large dot at the intersection of the axes. These are labeled in position angle, which is counted from north through east. The orientation of this diagram thus matches the view through an inverting telescope, for an observer in moderate northerly latitude as Delta Cygni crosses the meridian.

MOON PHASES AND DISTANCE

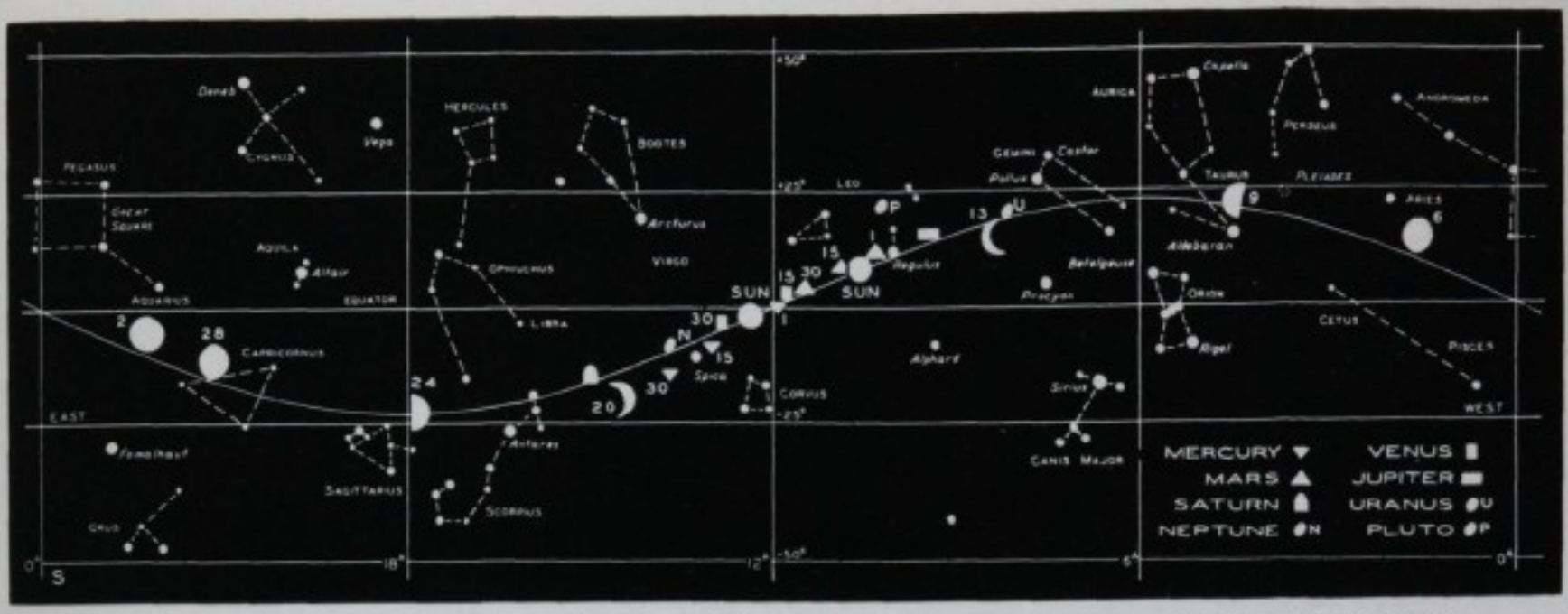
Full moon	September	2, 07:59
Last quarter	September	9, 07:59
New moon	September	16, 06:19
First quarter	September	24, 03:40
Full moon	October	1, 19:17

	September	Distance	Diameter
Perigee	10, 01ʰ	229,800 mi.	32′ 19″
Apogee	23, 11ʰ	251,200 mi.	29′ 34″
	October		
Perigee	5, 11ʰ	228,200 mi.	32′ 32″

FIREBALL OBSERVATION

On June 15, 1955, at 9:18 p.m. CST, I saw a fireball, deep blue in color, travel from Beta Bootis to a point 1½ degrees below Arcturus. There were three distinct explosions, one at the beginning of the path, the second a third of the way, and the last at the end of the path. The explosions lit the landscape like brilliant lightning. No sound was heard. This observation was made from latitude 41° 35′.7 N., longitude 93° 11′.5 W.

DALE P. CRUIKSHANK
3655 67th St.
Des Moines 10, Iowa



THE SUN, MOON, AND PLANETS THIS MONTH

The sun, on the ecliptic, is shown for the beginning and end of the month. The moon's symbols give its phase roughly, with the date marked alongside. Each planet is located for the middle of the month and for other dates shown.

Mercury will be in the evening sky all month, attaining greatest elongation on the 18th, 26° 33′ east of the sun. For observers in mid-northern latitudes, Mercury then sets about three quarters of an hour after the sun and is a difficult object. In the tropics the planet will be easily visible, appearing at magnitude +0.3.

Venus enters the evening sky on September 1st, passing superior conjunction with the sun, and is not observable this month.

Earth arrives at heliocentric longitude 0° on September 23rd at 19:42 UT, when autumn begins in the Northern Hemisphere.

Mars is traveling close to the sun in the morning sky. This 2nd-magnitude object, rising 1¼ hours before the sun on the 30th, can at the end of the month be located with the unaided eye.

Jupiter, also in the morning sky, rises 2½ hours before the sun on the 15th. Moving eastward fairly rapidly in western Leo, Jupiter shines at magnitude −1.4 during the latter half of the month.

Saturn sets 2½ hours after the sun on September 15th and is moving slowly eastward in Libra. This will be the last opportunity to view Saturn in the evening sky this year. The ring system will be inclined 21°.5 in mid-September, with the northern face visible.

Uranus can be observed during morning hours as a 6th-magnitude object in Cancer. For a map of its path, see page 169 in the February, 1955, issue.

Neptune cannot be seen this month, due to its proximity to the sun.

E. O.

PREDICTIONS OF BRIGHT MINOR PLANET POSITIONS

Leto, 68, 9.3. Sept. 10, 0:42.6 −6-23; 20, 0:34.9 −6-51; 30, 0:26.1 −7-11. Oct. 10, 0:17.3 −7-19; 20, 0:09.7 −7-11; 30, 0:04.5 −6-42.

Pales, 49, 9.7. Sept. 20, 1:31.7 +15-02; 30, 1:26.1 +14-42. Oct. 10, 1:19.0 +14-07; 20, 1:11.3 +13-20; 30, 1:04.2 +12-30. Nov. 9, 0:58.8 +11-43.

Laetitia, 39, 8.8. Sept. 30, 2:30.9 +2-07. Oct. 10, 2:25.6 +0-43; 20, 2:18.6 −0-37; 30, 2:10.8 −1-47. Nov. 9, 2:03.2 −2-38; 19, 1:56.9 −3-07.

After the asteroid's name are its number and the magnitude expected at opposition. At 10-day intervals are given its right ascension and declination (1950.0) for 0h Universal time. In each case the motion of the asteroid is retrograde. Data are supplied by the IAU Minor Planet Center at the University of Cincinnati Observatory.

MODERN CONSTELLATIONS

Sighed Pegasus: "I once had room to fly,
But now they've gone and cluttered up the sky
With Coal-sacks, Furnaces, and Microscopes,
With Clocks, and Sextants, Pumps and Telescopes,
With Sculptor's Tools, and other knobby things
That bruise my flanks and tear my feathered wings!"

T. Stephanides

SUNSPOT NUMBERS

June 1, 15, 26; **2,** 16, 17; **3,** 9, 13; **4,** 16, 22; **5,** 19, 25; **6,** 20, 33; **7,** 20, 26; **8,** 18, 23; **9,** 18, 24; **10,** 23, 27; **11,** 40, 48; **12,** 32, 46; **13,** 33, 40; **14,** 36, 63; **15,** 34, 56; **16,** 51, 69; **17,** 48, 74; **18,** 49, 71; **19,** 51, 67; **20,** 53, 74; **21,** 34, 55; **22,** 21, 38; **23,** 9, 15; **24-27,** 0, 0; **28,** 6, 8; **29,** 12, 11; **30,** 18, 23. Means for June: 23.4 American; 33.1 Zurich.

Above are given the date, the American number, then the Zurich number. These are observed mean relative sunspot numbers, the American computed by D. W. Rosebrugh from AAVSO Solar Division observations, the Zurich numbers from Zurich Observatory and its stations in Locarno and Arosa.

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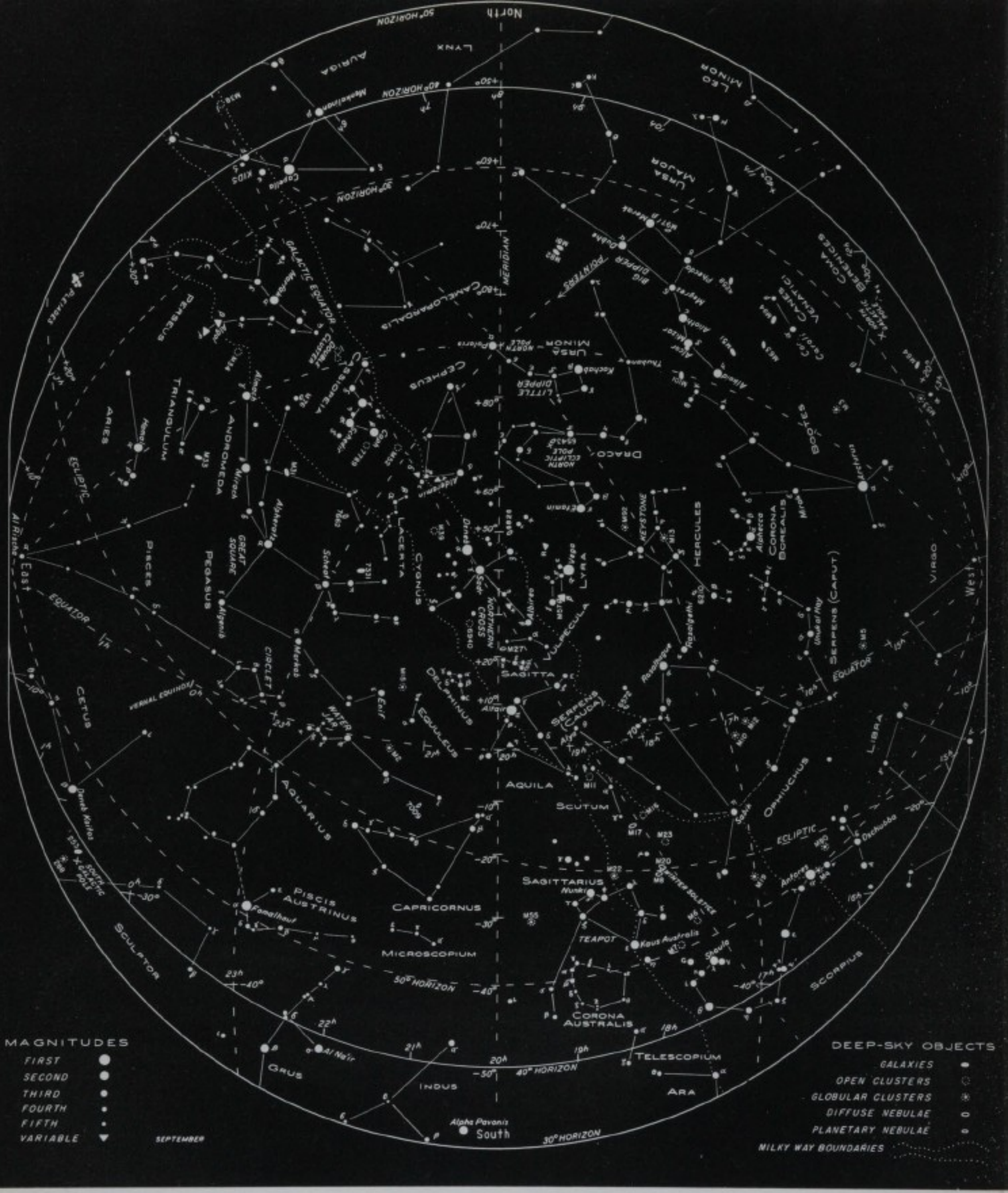

STARS FOR SEPTEMBER

The sky as seen from latitudes 30° to 50° north at 9 p.m. and 8 p.m., local time, on the 7th and 23rd of September, respectively; also, at 7 p.m. on October 7th. For other dates, add or subtract ½ hour per week.

Algol, the star Beta (β) in Perseus, is rising higher in the northeast. Its periodic dimming at intervals of about two days 21 hours, from magnitude 2.3 to 3.5, can be watched for. Use the Minima of Algol predictions given each month on the Observer's Page.

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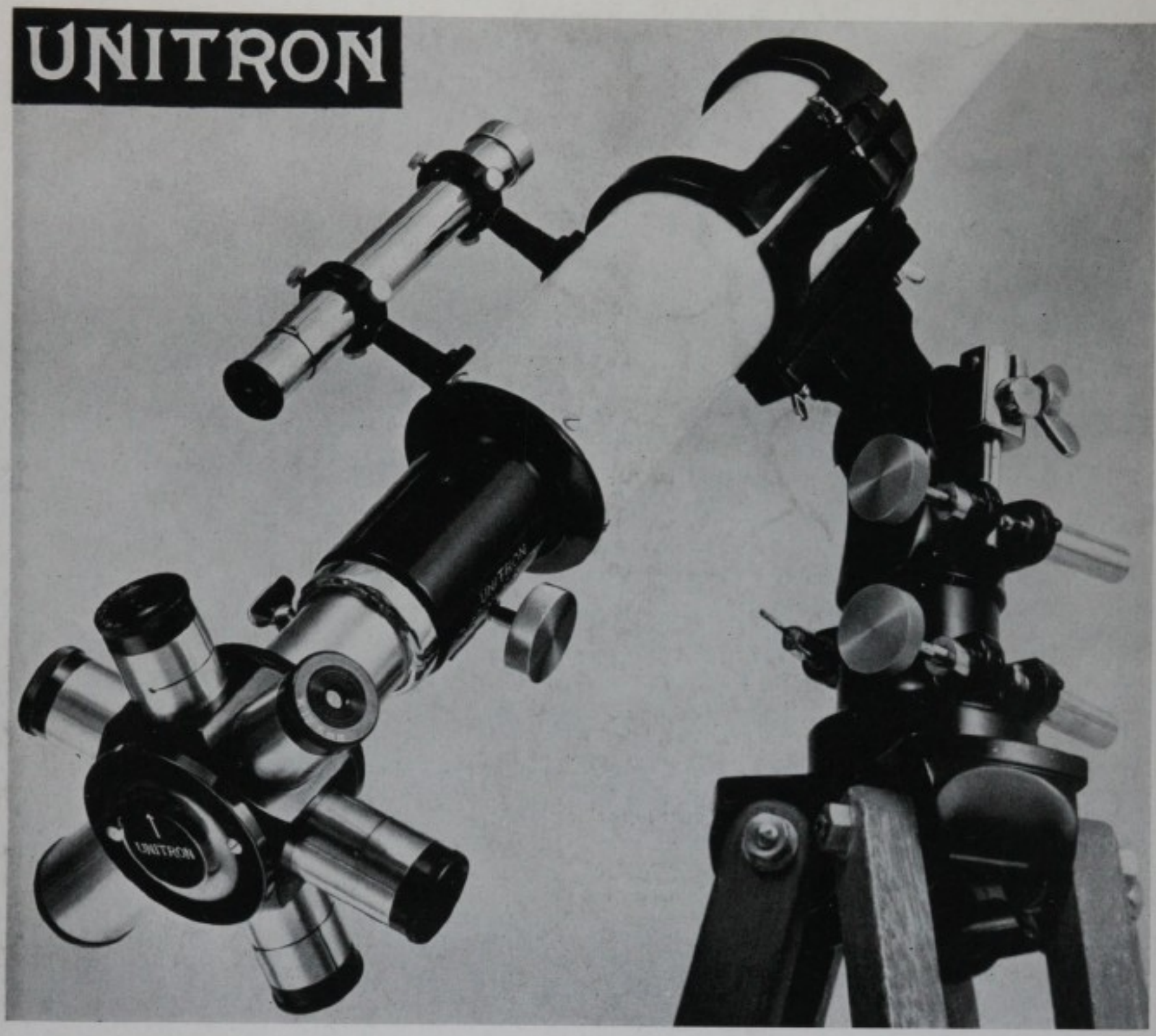

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See pages 468 and 483.

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